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DEVELOPMENT DOCUMENT
for
EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS
for the
PLASTICS MOLDING AND FORMING POINT SOURCE CATEGORY

William D. Ruckelshaus
Administrator

Jack E. Ravan
Assistant Administrator for Water

Steven Schatzow
Director
Office of Water Regulations and Standards

Jeffery D. Denit, Director
Effluent Guidelines Division

Robert M. Southworth, P.E.
Technical Project Officer

February 1984

U.S. Environmental Protection Agency
Office of Water
Office of Water Regulations and Standards
Effluent Guidelines Division
Washington, D.C. 20460

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16. ABSTRACT

This document presents technical information on which the proposed effluent limitations guidelines and standards for the plastics molding and forming (PMF) point source category are based. It includes information on the category profile, water use, wastewater characteristics, treatment technology options, treatment technology costs, treatment technology effluent quality, and production normalized flows. The proposed effluent limitations guidelines for the PMF category based on BPT, BAT, and BCT are presented in this document along with the proposed NSPS. No pretreatment standards are proposed for this category.

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SECTION I

SUMMARY AND CONCLUSIONS

Pursuant to Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act and the Settlement Agreement in Natural Resources Defense Council v. Train 8 ERC 2120 (D.D.C. 1976) modified 12 ERC 1833 (D.D.C. 1979), modified by orders dated October 26, 1982, August 2, 1983, and January 6, 1984, the Environmental Protection Agency (EPA) collected and analyzed data for plants in the Plastics Molding and Forming Point Source category. (Throughout this document the Plastics Molding and Forming category is referred to as the "PM&F" category.) There are no existing effluent limitations guidelines or standards for this category. This document and the administrative record provide the technical basis for the proposed effluent limitations guidelines for existing direct dischargers, pretreatment standards for new and existing indirect dischargers, and standards of performance for new source direct dischargers.

In the PM&F category there are an estimated 10,260 plants of which 1,898 use process water (i.e., water that contacts the plastic material during processing). These plants have approximately 2,522 processes that use process water. Of these processes, 789 discharge water directly to rivers and streams; 1,117 discharge to publicly owned treatment works; and 616 do not discharge process water. The other 8,362 plants in the PM&F category do not use process water (i.e., they are dry).

To collect information regarding plant size, age and production, the production processes used, and the quantity, treatment, and disposal of wastewater generated, EPA conducted three questionnaire surveys and a two-part telephone survey. As a result of these surveys, 408 plants were included in a data base from which were derived technical, statistical, and economic information to evaluate the PM&F category. In addition, EPA sampled PM&F processes at 11 plants: four plants were sampled in 1980 and seven plants were sampled in 1983. Samples collected were analyzed for conventional, selected nonconventional, and priority toxic pollutants to identify pollutants present in the PM&F wastewater.

The Agency examined data obtained from the questionnaire surveys and the wastewater sampling program to characterize the PM&F category. The category is comprised of plants that employ eight generic processes that blend, mold, form, or otherwise process plastic materials. These processes are:

1. extrusion,
2. molding,
3. coating and laminating,

4. thermoforming,
5. calendering,
6. casting,
7. foaming, and
8. cleaning and finishing.

Results of the sampling program indicate that, with the exception of cleaning and finishing processes, process water is used to cool or heat the products produced in PM&F processes and that the contact cooling or heating water has similar pollutant characteristics regardless of the type of process or plastic product produced. Water used in cleaning and finishing processes has different pollutant characteristics than contact cooling and heating water. Because the characteristics are different, a different type of recycle unit has to be used to recycle contact cooling and heating water and cleaning and finishing water. For these reasons, the PM&F category was divided into two subcategories:

1. contact cooling and heating water subcategory, and
2. cleaning and finishing water subcategory.

The contact cooling and heating water subcategory includes those processes where process water contacts raw materials or plastics products for the purpose of heat transfer during plastics molding and forming. In identifying model treatment technology options for this subcategory, the Agency found that further division based on average process water usage flow rate was required. Thus, processes with an average process water usage flow rate of 35 gpm or less are in one subdivision and processes with an average process water usage flow rate greater than 35 gpm are in a different subdivision.

The cleaning and finishing subcategory includes those processes that use process water to clean or finish the plastic product or to clean shaping equipment that is or has been in contact with the formed plastic product. Process water used to clean the plastic product or shaping equipment includes water used in the detergent wash cycle and water used in the rinse cycle to remove detergents and other foreign matter. Finishing water consists of water used to carry away waste plastic material or to lubricate the product during finishing processes.

Only process water that contacts the plastic material, plastic product, or shaping equipment used to mold or form plastic materials is covered by the proposed regulation. Non-contact cooling water is not process water and thus is not controlled. Permitting and control authorities will establish limitations for the discharge of non-contact cooling water and other non-process wastewater on a case-by-case basis.

Plants in the PM&F category may have processes that use only one type of water and thus fit within one subcategory. However, many plants use both contact cooling and heating water and cleaning and finishing water. In this instance, plants must comply with the proposed effluent limitations guidelines and standards for both subcategories.

EPA studied the PM&F category to characterize the pollutants in the different types of process water. The conventional and nonconventional pollutants present in significant concentrations are: (1) conventional pollutants - biochemical oxygen demand (BOD_5), suspended solids (TSS), oil and grease, and pH (2) nonconventional pollutants - total organic carbon, chemical oxygen demand, and total phenols. The priority toxic pollutants found in the process water are: (1) contact cooling and heating water, benzene, carbon tetrachloride, 1,1,1-trichloroethane, p-chloro-m-cresol, chloroform, methylene chloride, phenol, bis(2-ethylhexyl) phthalate, di-n-butyl phthalate, tetrachloroethylene, toluene, aldrin, dieldrin, 4,4'-DDE, heptachlor, α-BHC, β-BHC, γ-BHC, δ-BHC, cadmium, total chromium, copper, lead, mercury, nickel, and zinc and, (2) cleaning and finishing water - benzene, chloroform, methylene chloride, N-nitrosodiphenylamine, phenol, bis(2-ethylhexyl) phthalate, toluene, aldrin, heptachlor, α-BHC, γ-BHC, δ-BHC, total chromium, copper, nickel, selenium, and zinc.

The control and treatment technologies available for this category include both in-process and end-of-pipe technologies. These technologies were considered appropriate for the treatment of plastics molding and forming wastewater and formed the basis of the technology options for the model regulatory treatment technologies.

The model in-process control technology basis for the proposed effluent limitations guidelines and standards is recycle of the process water (i.e., flow reduction). Recycle consists of returning the process water to the process so that it can be used again for the same purpose. By reducing the amount of water discharged, the size and cost of the technologies used to treat the discharge are reduced. Additionally, treatment technology performance may be improved using a recycle system because the concentrations of the pollutants in the discharge from the recycle unit are higher than the concentrations in the process water. Treatment technologies usually perform better with a more concentrated wastewater.

Process water that requires cooling prior to recycle is recycled through a technology that lowers the temperature of the water. One type of recycle unit is a holding tank. Process water is held in the tank until the temperature drops through passive heat transfer to the environment. Application of this recycle unit is limited to low flow rate processes.

Another type of recycle unit is a chiller. Chillers cool the process water by mechanical refrigeration. They can be used with higher flow rate processes simply by adding the number of chillers needed to provide the required amount of refrigeration. However, at the high flow rates, the high energy cost per unit of cooling makes the chiller less attractive than other recycle units such as a cooling tower.

A cooling tower lowers water temperature by evaporative cooling. Water flows over the surfaces of the cooling tower and is cooled when it contacts the air that is blown into the tower. This unit is particularly appropriate for high flow rate processes because of its small space and low energy requirements.

A sedimentation tank may be used to recycle process water that requires the removal of either solids or oil and grease. The solids settle to the bottom of the tank and are removed; oil and grease are skimmed off of the tank water surface. The treated water is then recycled to the process.

End-of-pipe technologies considered appropriate for PM&F wastewater include pH adjustment, sedimentation, and the activated sludge process.

pH Adjustment. Acidic and basic materials are used to control the pH of the wastewater. Proper pH adjustment not only controls a pollutant property but also serves to ensure proper treatment technology performance.

Sedimentation. Sedimentation is a process that removes solid particles from a liquid matrix by gravitational force. This is done by reducing the velocity of the flow in a large volume tank so that gravitational settling can occur. Floatable materials such as oils can also be removed in this process by skimming them from the surface of the water in the tank.

Biological Treatment (Activated Sludge). The activated sludge process is a widely used biological treatment process characterized by a suspension of microorganisms maintained in a homogeneous state by mixing and turbulence induced by aeration. The microorganisms oxidize soluble and colloidal organic material to carbon dioxide and water in the presence of molecular oxygen. This process treats dissolved pollutants such as biochemical oxygen demand (BOD_5), total organic carbon, and total phenols. The activated sludge process, which is designed to assure optimal removal of BOD_5, also removes organic priority pollutants in the wastewater.

Activated sludge technology can be used with sedimentation technologies to make a package activated sludge plant. These are self-contained plants that usually consist of a primary sedimentation unit, an activated sludge unit, and a final sedimentation unit. Package activated sludge plants can be used to treat flows from as low as 600 gallons per day to as high as 100,000 gallons per day.

Using these technologies the Agency developed several treatment options. After consideration of these options, the Agency selected the following model treatment technologies as the basis for this proposed regulation.

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Best Practical Technology (BPT) Effluent Limitations Guidelines

For the Best Practical Control Technology (BPT) effluent limitations guidelines, the following technologies are proposed as the model treatment technologies:

For processes with an average process water usage flow rate of 35 gpm or less - Zero discharge by 100 percent recycle of the process water using either a tank or chiller.

For processes with an average process water usage flow rate greater than 35 gpm - Recycle through a cooling tower and treatment of the recycle unit discharge in a package activated sludge plant. An equalization tank is included as part of the package plant.

Under BPT, the Agency proposes effluent limitations guidelines for biochemical oxygen demand, total suspended solids, oil and grease, and pH. EPA estimates that 79 percent of the nonconventional pollutants and 80 percent of the toxic pollutants for this subcategory are removed when the limitations for the above pollutants are met. The Agency is proposing mass-based BPT effluent limitations expressed in terms of the allowable mass of pollutant discharged per unit of production. This reflects the reduction in flow and the reducion in pollutant concentrations achieved by application of the BPT model technology.

The proposed technology option results in no discharge of pollutants from processes with an average process water usage flow rate of 35 gpm or less and significantly reduces the concentration of conventional, nonconventional, and priority pollutants discharged by processes with an average process water usage flow rate greater than 35 gpm.

Best Available Technology (BAT) Effluent Limitations Guidelines

The Agency is not proposing BAT effluent limitations guidelines more stringent than the proposed BPT effluent limitations guidelines for this subcategory because there are insignificant quantities of toxic pollutants remaining in contact cooling and heating water after compliance with the applicable BPT effluent limitations guidelines. The Agency believes that the amount and toxicity of these pollutants do not justify establishing more stringent BAT effluent limitations guidelines for the toxic pollutants.

Best Conventional Technology (BCT) Effluent Limitations Guidelines

The Agency reviewed treatment technologies that could be used to remove additional conventional pollutants after BPT in contact cooling and heating water. The only technology considered feasible is flow reduction and zero discharge by contract haul of the discharge from the flow reduction unit. The costs to achieve the additional removal of conventional pollutants do not pass a proposed two-part "cost-reasonableness" test. The Agency proposes, therefore, that BCT equal BPT for contact cooling and heating water and that no further controls be established for the conventional pollutants beyond BPT.

New Source Performance Standards (NSPS)

The Agency believes that characteristics of wastewater discharged by new PM&F processes in the contact cooling and heating water subcateogry will be the same as the characteristics of wastewater discharged by existing PM&F processes in this subcategory. Thus, the Agency is proposing NSPS based on the same model treatment technologies used to develop the proposed BPT/BAT effluent limitations guidelines for this subcategory. EPA is not proposing NSPS more stringent than the effluent limitations guidelines for existing sources because the amount and toxicity of the toxic pollutants remaining after treatment in the BPT model treatment technologies for this subcategory do not justify more stringent controls.

Pollutants controlled by NSPS include biochemical oxygen demand, total suspended solids, oil and grease, and pH. The Agency believes that the toxic pollutants in contact cooling and heating water are effectively controlled when the NSPS for the above pollutants are met. NSPS are expressed in terms of the allowable mass of pollutant discharged per unit of plastic production.

Pretreatment Standards for Existing Sources (PSES)

The Agency is not proposing PSES for existing indirect dischargers for this subcategory because the priority toxic pollutants in contact cooling and heating water either do not pass through a publicly owned treatment works (POTW) or the amount and toxicity do not justify establishing pretreatment standards.

Even though plants within this subcategory are not regulated by categorical pretreatment standards, they must comply with the General Pretreatment Regulations (40 CFR Part 403).

Pretreatment Standards for New Sources (PSNS)

The Agency is also not proposing PSNS for new indirect dischargers in this subcategory because the priority toxic polutants in contact cooling and heating water either do not pass through a POTW or the amount and toxicity do not justify establishing pretreatment standards. Plants within this subcategory must comply with General Pretreatment Regulations (40 CFR Part 403) even though the Agency is not proposing to establish categorical pretreatment standards.

CLEANING AND FINISHING WATER SUBCATEGORY

Best Practical Technology (BPT) Effluent Limitations Guidelines

The Agency is proposing BPT effluent limitations guidelines for this subcategory based on recycle of process water through a sedimentation tank and treatment of the discharge from the recycle unit in a package activated sludge plant. The package plant includes an equalization unit and pH adjustment. A sedimentation tank is used to remove suspended solids so that the wastewater can be recycled.

Under BPT, the Agency proposes to establish limitations guidelines for biochemical oxygen demand, total suspended solids, oil and grease, and pH. EPA believes that the toxic pollutants in cleaning and finishing water are effectively controlled when the limitations for the above pollutants are met.

The Agency is proposing mass-based BPT effluent limitations guidelines expressed in terms of the allowable mass of pollutant discharged per unit of production. This reflects the reduction in flow and the reduction in pollutant concentrations achieved by application of the BPT model treatment technology.

The Agency determined that two separate mass-based effluent limitations guidelines are necessary for this subcategory because of the difference in the amounts of wastewater discharged from cleaning as opposed to finishing processes. Therefore, mass-based effluent limitations guidelines are proposed for processes that use cleaning water and for processes that use finishing water. The effluent concentration value used to calculate the allowable discharge mass are the same for both cleaning and finishing processes. However, the production normalized flows are different for those processes.

Best Available Technology (BAT) Effluent Limitations Guidelines

The Agency is not proposing BAT effluent limitations guidelines more stringent than the proposed BPT effluent limitations guidelines for this subcategory because there are insignificant quantities of toxic pollutants remaining in cleaning and finishing water after compliance with the applicable BPT effluent limitations guidelines. The Agency believes that the amount and toxicity of these pollutants do not justify establishing more stringent BAT effluent limitations guidelines for the toxic pollutants.

Best Conventional Technology (BCT) Effluent Limitations Guidelines

The Agency reviewed treatment technologies that could be used to remove additional conventional pollutants after BPT in cleaning and finishing water. The only technology considered feasible is flow reduction and zero discharge by contract haul of the discharge from the flow reduction unit. The costs to achieve the additional removal of conventional pollutants do not pass a proposed two-part "cost-reasonableness" test. The Agency proposes, therefore, that BCT equal BPT for cleaning and finishing water and that no further controls be established for the conventional pollutants beyond BPT.

New Source Performance Standards (NSPS)

The Agency believes that characteristics of wastewater discharged by new PM&F processes in the cleaning and finishing water subcategory will be the same as the characteristics of wastewater discharged by existing PM&F processes in this subcategory. Thus, the Agency is proposing NSPS based on the same model treatment technologies as the proposed BPT/BAT effluent limitations guidelines. EPA is not proposing NSPS more stringent than the effluent limitations guidelines for existing sources because the amount and toxicity of the toxic pollutants remaining after treatment in the BPT/BAT treatment technologies for this subcategory do not justify more stringent controls.

Pollutants controlled by NSPS include biochemical oxygen demand, total suspended solids, oil and grease, and pH. The Agency believes that the toxic pollutants for cleaning and finishing water are effectively controlled when the NSPS for the above pollutants are met. NSPS are expressed in terms of the allowable mass of pollutant discharged per unit of production.

Pretreatment Standards for Existing Sources (PSES)

The Agency is not proposing PSES for existing indirect dischargers in this subcategory because the priority toxic pollutants in cleaning and finishing water either do not pass through a publicly owned treatment works (POTW) or the amount and toxicity do not justify pretreatment standards. Even though plants within this subcategory are not regulated by proposed categorical pretreatment standards, they must comply with General Pretreatment Regulations (40 CFR Part 403).

Pretreatment Standards for New Sources (PSNS)

The Agency is also not proposing PSNS for new indirect dischargers in this subcategory because the priority toxic polutants in cleaning and finishing water either do not pass through a POTW or the amount and toxicity do not justify pretreatment standards. Plants within this subcategory must comply with the General Pretreatment Regulations (40 CFR Part 403) even though the Agency is not proposing to establish categorical pretreatment standards.

SECTION II

RECOMMENDATIONS

1. EPA has divided the plastics molding and forming category into two subcategories for the purpose of the proposed effluent limitations guidelines and standards. They are:

   - contact cooling and heating water subcategory, and
   - cleaning and finishing water subcategory.

2. Best Practical Technology (BPT) effluent limitations guidelines are being proposed based on the treatment effectiveness achievable by the application of process water recycle and packaged activated sludge treatment for process water discharged from the recycle unit for both subcatgories. In addition, 100 percent recycle of process water is being proposed for processes that use contact cooling and heating water and that have an average process water usage flow rate of 35 gpm or less.

A. BPT EFFLUENT LIMITATIONS GUIDELINES FOR THE CONTACT COOLING AND HEATING WATER SUBCATEGORY

There shall be no discharge of wastewater pollutants from contact cooling and heating water processes with an average process water usage flow rate of 35 gpm (132 liters per minute) or less.

The mass of pollutants in process wastewater from contact cooling and heating water processes with an average process water usage flow rate greater than 35 gpm (132 liters per minute) shall not exceed the following values:

Contact Cooling and Heating Water

Pollutant or pollutant property	BPT effluent limitations Maximum for any 1 day	BPT effluent limitations Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	78	35
Oil and Grease	113	27
TSS	186	57
pH	(1)	(1)

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[1] Within the range of 6.0 to 9.0 at all times.

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B. BPT EFFLUENT LIMITATIONS GUIDELNES FOR THE CLEANING AND FINISHING WATER SUBCATEGORY

The mass of pollutants in process water discharged from existing plastics molding and forming cleaning processes shall not exceed the following values:

Cleaning Water

Pollutant or pollutant property	BPT effluent limitations	
	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	220	99
Oil and Grease	318	76
TSS	524	161
pH	(1)	(1)

---

[1] Within the range of 6.0 to 9.0 at all times.

The mass of pollutants in process water discharged from existing plastics molding and forming finishing processes shall not exceed the following values:

Finishing Water

Pollutant or pollutant property	BPT effluent limitations	
	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	52	23
Oil and Grease	76	18
TSS	125	38
pH	(1)	(1)

---

[1] Within the range of 6.0 to 9.0 at all times.

3. The Agency has determined that there are insignificant quantities of toxic pollutants in wastewaters discharged by processes in both subcategories after compliance with applicable BPT effluent limitations guidelines. Accordingly, since BPT level of treatment provides adequate control, the Agency is not proposing more stringent Best Available Technology (BAT) effluent limitations guidelines.

4. EPA reviewed treatment technologies that could be used to remove additional conventional pollutants after BPT. The only technology considered feasible is flow reduction and zero discharge by contract haul of the discharge from the flow reduction unit. The removals by this technology did not pass the two-part cost test in the proposed BCT methodology. Therefore, the Agency proposes that BCT equal BPT for each subcategory and that no further controls be established for the conventional pollutants beyond BPT.

   The BCT effluent limitations guidelines for each subcategory are being proposed based on the treatment effectiveness achievable by the application of process water recycle and packaged activated sludge treatment for process water discharged from the recycle unit. For processes with contact cooling and heating water that have an average process water usage flow rate of 35 gpm or less, 100 percent recycle of process water is being proposed.

A. BCT EFFLUENT LIMITATIONS GUIDELINES FOR THE CONTACT COOLING AND HEATING WATER SUBCATEGORY

There shall be no discharge of conventional pollutants from contact cooling and heating processes with an average process water usage flow rate of 35 gpm (132 liters per minute) or less.

The mass of conventional pollutants in process water discharged from contact cooling and heating water processes with an average process water usage flow rate greater than 35 gpm (132 liters per minute) shall not exceed the following values:

Contact Cooling and Heating Water

Pollutant or pollutant property	BCT effluent limitations Maximum for any 1 day	 Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	78	35
Oil and Grease	113	27
TSS	186	57
pH	(1)	(1)

[1] Within the range of 6.0 to 9.0 at all times.

B. BCT EFFLUENT LIMITATIONS GUIDELINES FOR THE CLEANING AND FINISHING WATER SUBCATEGORY

The mass of conventional pollutants in process water discharged from existing plastics molding and forming cleaning processes shall not exceed the following values:

Cleaning Water

Pollutant or pollutant property	BCT effluent limitations Maximum for any 1 day	 Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	220	99
Oil and Grease	318	76
TSS	524	161
pH	(1)	(1)

[1] Within the range of 6.0 to 9.0 at all times.

The mass of conventional pollutants in process water discharged from existing plastics molding and forming finishing processes shall not exceed the following values:

Finishing Water

Pollutant or pollutant property	BCT effluent limitations Maximum for any 1 day	 Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	52	23
Oil and Grease	76	18
TSS	125	38
pH	([1])	([1])

[1] Within the range of 6.0 to 9.0 at all times.

5. The EPA also proposes New Source Performance Standards (NSPS) based on process water recycle and package activated sludge treatment for process water discharged from the recycle unit for both subcategories. Additionally, 100 percent recycle of process water is being proposed for processes with contact cooling and heating water that have an average process water usage flow rate of 35 gpm or less.

A. NSPS FOR THE CONTACT COOLING AND HEATING WATER SUBCATEGORY

There shall be no discharge of wastewater pollutants from processes in the contact cooling and heating water subcategory at a new source with an average process water usage flow rate of 35 gpm (132 liters per minute) or less.

The mass of pollutants in process water discharged from processes in the contact cooling and heating water subcategory at a new source with an average process water usage flow rate greater than 35 gpm (132 liters per minute) shall not exceed the following values:

Contact Cooling and Heating Water

Pollutant or pollutant property	New Source Performance Standards Maximum for any 1 day	 Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	78	35
Oil and Grease	113	27
TSS	186	57
pH	(1)	(1)

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[1] Within the range of 6.0 to 9.0 at all times.

B. NSPS FOR THE CLEANING AND FINISHING WATER SUBCATEGORY

The mass of pollutants in process water discharged from plastics molding and forming cleaning processes at a new source shall not exceed the following values:

Cleaning Water

Pollutant or pollutant property	New Source Performance Standards Maximum for any 1 day	 Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	220	99
Oil and Grease	318	76
TSS	524	161
pH	(1)	(1)

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[1] Within the range of 6.0 to 9.0 at all times.

The mass of pollutants in process water discharged from plastics molding and forming finishing processes at a new source shall not exceed the following values:

Finishing Water

Pollutant or pollutant property	New Source Performance Standards Maximum for any 1 day	 Maximum for monthly average
	mg/kg (pounds per million pounds) of plastic material processed	
BOD_5	52	23
Oil and Grease	76	18
TSS	125	38
pH	([1])	([1])

---

[1] Within the range of 6.0 to 9.0 at all times.

6. The Agency is not proposing to establish Pretreatment Standards for Existing Sources (PSES) for the PM&F category. Even though plants within this category are not regulated by PSES, they must comply with the General Pretreatment Regulations (40 CFR Part 403).

7. The Agency is not proposing to establish Pretreatment Standards for New Sources (PSNS) in the PM&F category. Although indirect discharges within this category are not subject to PSNS, they must comply with the General Pretreatment Regulations (40 CFR Part 403).

SECTION III

INTRODUCTION

BACKGROUND

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," under Section 101(a). By July 1, 1977, existing industrial dischargers were required to achieve "effluent limitations requiring the application of the best practicable control technology currently available" (BPT), under Section 301(b)(1)(A); and by July 1, 1984, "effluent limitations requiring the application of the best available technology economically achievable . . . which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants" (BAT), under Section 301(b)(2)(A). New industrial direct dischargers were required to comply with Section 306 new source performance standards (NSPS), based on best available demonstrated technology; existing and new dischargers to publicly owned treatment works (POTW) were subject to pretreatment standards under Sections 307(b) (PSES) and (c) (PSNS), respectively, of the Act.

The requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under Section 402 of the Act while pretreatment standards were made enforceable directly against dischargers to a POTW (indirect dischargers). Although Section 402(a)(1) of the 1972 Act authorized the setting of NPDES permit requirements for direct dischargers on a case-by-case basis, Congress intended that, for the most part, effluent limitations guidelines be based on the degree of effluent reduction attainable through the application of BPT and BAT. Moreover, Sections 304(c) and 306 of the Act required promulgation of new source performance standards; and Sections 304(f), 307(b), and 307(c) required promulgation of pretreatment standards. In addition to the effluent limitations guidelines and standards for designated industry categories, Section 307(a) of the Act required the Administrator to promulgate effluent standards for toxic pollutants applicable to all dischargers of these pollutants. Finally, Section 301(a) of the Act authorized the Administrator to prescribe any additional regulations "necessary to carry out his functions" under the Act.

EPA was unable to promulgate many of the effluent limitations guidelines and standards by the dates contained in the Act. In 1976, EPA was sued by several environmental groups and in settlement of this lawsuit, EPA and the plaintiffs executed a "Settlement Agreement" that was approved by the Court. This agreement required EPA to develop a program and adhere to a schedule for

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promulgating BAT effluent limitations guidelines, pretreatment standards, and new source performance standards for 65 "priority" compounds and classes of compounds for 21 major industries. See, Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified 12 ERC 1833 (D.D.C. 1979), modified by orders dated October 26, 1982, August 2, 1983, and January 6, 1984.

On December 27, 1977, the President signed into law amendments to the Federal Water Pollution Control Act (P.L. 95-217). The Act, as amended, is commonly referred to as the Clean Water Act. Although this Act makes several important changes in the federal water pollution control program, its most significant feature is its incorporation of several of the basic elements of the Settlement Agreement program for toxic pollution control. Sections 301(b)(2)(C) and 301(b)(2)(D) of the Act now require the achievement by July 1, 1984, of effluent limitations guidelines requiring application of BAT for toxic pollutants, including the 65 priority compounds and classes of compounds (the same toxic pollutants as listed in Natural Resources Defense Council, Inc. v. Train, supra) Congress declared toxic under Section 307(a) of the Act. Likewise, EPA's program for new source performance standards is now aimed principally at control of these toxic pollutants. Pretreatment standards control the toxic pollutants and pollutants that are incompatible with a POTW. Moreover, to strengthen the toxics control program, Congress added Section 304(e) to the Act, authorizing the Administrator to prescribe "best management practices" (BMP) to prevent the release of toxic and hazardous pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage associated with, or ancillary to, the manufacturing or treatment process.

In keeping with its emphasis on toxic pollutants, the Clean Water Act also revised the control program for other types of pollutants. Instead of BAT for "conventional" pollutants identified under Section 304(a)(4) (including biological oxygen demand, suspended solids, oil and grease, fecal coliform, and pH), the new Section 301(b)(2)(E) requires achievement, by July 1, 1984, of "effluent limitations requiring the application of the best conventional pollutant control technology" (BCT). The factors considered in assessing BCT for an industry include a two-part "cost-resonableness" test (Section 304(b)(4)(B). See, American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981). The first part compares the cost for private industry to reduce its conventional pollutants with the costs for publicly owned treatment works for similar levels of reduction of those pollutants. The second part examines the cost effectiveness of additional industrial treatment beyond BPT.

For nonconventional pollutants, Sections 301(b)(2) (A) and (b)(2)(F) require achievement of BAT effluent limitations guidelines within three years after their establishment, or not later than July 1, 1984, whichever is later, but in no case later than July 1, 1987.

PURPOSE

This document presents the information and data used to develop the proposed effluent limitations guidelines and standards for the plastics molding and forming (PM&F) point source catetgory.

AUTHORITY

Effluent limitations guidelines and standards for the PM&F category are proposed under authority of Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1251 *et seq.*, as amended by the Clean Water Act of 1972, Pub. L. 95 - 217) (the "Act"). This regulation is also proposed in response to the Settlement Agreement in *Natural Resources Defense Council, Inc. v. Train*, 8 ERC 2120 (D.D.C. 1976), *modified* 12 ERC 1833 (D.D.C. 1979), *modified* by orders dated October 26, 1982, August 2, 1983 and January 6, 1984.

STUDY APPROACH

The study approach used to develop the proposed PM&F effluent limitations guidelines and standards included the following:

1. The Agency conducted three questionnaire surveys and a two part telephone survey to gather information on production, manufacturing processes, water use and discharge practices, and wastewater treatment.

2. A PM&F category profile was developed using the survey information and information from literature sources.

3. The PM&F category was subcategorized based on information from the questionnaire surveys and information from the wastewater sampling programs.

4. EPA sampled 11 PM&F plants to characterize PM&F process water. Samples were analyzed for conventional, selected nonconventional, and priority toxic pollutants.

5. Results of the sampling episodes were used to determine the pollutants in PM&F wastewater that have significant concentrations.

6. Control and treatment technologies that effectively control the pollutants in PM&F wastewater were evaluated.

7. Costs, pollutant removals, energy, and non-water quality aspects were evaluated for the various treatment technologies.

8. A model treatment technology was selected for BPT, BAT, BCT, and NSPS.

9. Effluent concentration data for the model treatment technologies were obtained.

10. Production normalized flows were developed for each subcategory.

11. Mass-based effluent limitations guidelines and standards were developed by multiplying the effluent concentration data for the selected model treatment technology times the production normalized flows.

SECTION IV

CATEGORY PROFILE

The plastics molding and forming (PM&F) category covers a large, diverse industry that uses plastic materials to produce a wide variety of consumer and industrial products. Since shortly after the discovery of plastic materials, nearly 60 years ago, molding and forming processes have been used to turn those plastic materials into usable items. Originally, plastic products were typically considered to be inexpensive substitutes for wood, leather, and metal items. However, in many cases, plastic products have virtually replaced other products due to their superior characteristics, such as light weight, durability, and resistence to corrosion. New product uses for plastics as well as new plastic formulations are continually being developed. The products produced by the plastics molding and forming category are used in a wide variety of consumer and industrial markets including: automobiles, appliances and business machines, construction materials, disposables, household furnishings, housewares, and medical products. The PM&F category is classified as Industry 3079, Miscellaneous Plastics Products, in the Standard Industrial Classification Manual prepared by the Office of Management and Budget.

In the course of developing the proposed effluent limitations guidelines and standards for the plastics molding and forming category, several data gathering efforts were undertaken to characterize the category. They included:

- reviewing existing National Pollutant Discharge Elimination System (NPDES) permits,
- sampling at PM&F plants,
- conducting questionnaire and telephone surveys, and
- reviewing various literature sources.

NPDES PERMITS

Existing NPDES permits for PM&F plants were reviewed to determine the pollutants controlled and the allowable concentration values for those pollutants. As of August 1983, there were 433 PM&F plants with NPDES permits. Eleven of those plants are major dischargers. Permits for eight of the major dischargers were reviewed. Table IV-1 lists the PM&F process, existing treatment technology, and pollutants controlled for these eight major dischargers.

Table IV-1

SUMMARY OF MAJOR NPDES PERMITS

Permit Number	Process	Treatment Technology	Pollutants Limited by Permit
NJ 0031313	Not described in permit	No treatment is described in permit	TOC, temperature, pH
PA 0013218	Extrusion of packaging films and bags	No treatment is described in permit	Oil and grease, pH, zinc, temperature
DE 0000451	Manufacture of vulcanized fiber and waterleaf paper	Plant has an aeration system for an integrated facility	BOD, TSS, zinc, temperature, effluent flow
IN 000160	Manufacture of food packaging films and household product containers	PM&F process wastewater not treated; plant has an activated sludge system for domestic waste	BOD, residual chloride, TSS, total zinc, PCBs and dithiocarbonates must be monitored for three months before determining limits
IN 0109541	Not described in permit	No treatment is described in permit	TSS, oil and grease, total and hexavalent chromium, total cyanide, total nickel, total copper
TN 0001457	Manufacture of cellulose packaging films	No treatment is described in permit; from questionnaire information, the plant has a lime and settle system as part of an integrated treatment facility	BOD, suspended solids, settleable solids, aluminum, iron, manganese, hydrogen sulfide, total dissolved sulfide, pH
GA 0000329	Manufacture of rubber	No treatment is described in permit	COD, BOD, TSS, oil and grease, ammonia as N, fecal coliform
KS 0003204	Manufacture of cellophane films	Plant has an activated sludge system; results of telephone conversation indicate that a large percentage of wastewater treated in an activated sludge process is PM&F wastewater	BOD, COD, TSS, temperature, pH

SAMPLING PROGRAM

Information on the PM&F category was gathered during the wastewater sampling programs for this project. Eleven PM&F plants were sampled, seven in 1983 and four in 1980. Flow measurements taken at the sampled plants provided information on water use and discharge practices. Wastewater samples were collected and analysed for conventional, nonconventional, and priority pollutants. A discussion of the sampling programs including results is presented in Section VI and Appendix A.

QUESTIONNAIRE SURVEYS

The plastics molding and forming category was surveyed to gather information on plant size and age, production, production processes used, and the quantity, treatment, and disposal of wastewater generated at PM&F plants. This information was requested in three questionnaires mailed under authority of Section 308 of the Act to companies known or believed to be involved in plastics molding or forming. A two-part telephone survey was used to develop the sample population for the third questionnaire survey.

1978 and 1979 Questionnaire Surveys

In 1978, 8,450 firms were sent a one-page questionnaire. The names and addresses of the plants on the mailing list for this questionnaire were compiled from the following sources:

1. Dun & Bradstreet, Inc. and
2. Fortune 500.

The questionnaire asked if the company was a plastics molder and former, if process water was used, (i.e., water that contacts the plastic product), what type of discharge mode was used, what plastic materials were used, and what products were produced at the plant. When firms had plastics molding and forming processes at more than one location, a questionnaire was completed for each plant. A total of 5,138 questionnaires were returned: 1,114 indicated the plant uses process water in a PM&F process and 4,024 indicated the plant did not use process water.

From the 1,114 respondents to the 1978 survey that indicated they use process water, 750 plants were mailed a more detailed questionnaire in 1979. Approximately 59 percent of the companies responded to the survey. Of the 440 respondents to the survey, 407 returned completed questionnaires and 33 indicated they had responded incorrectly to the one page questionnaire and had only dry processes (i.e., process water did not contact the formed plastic product). Seventy five of the 407 returned questionnaires contained unclear data. Data from the other 332 questionnaires were included in the data base for this project.

Table IV-2 contains a distribution of the types of processes reported on the 1979 questionnaire and indicates the number of processes for each type that generate wastewater and that do not generate wastewater. The total number of processes is larger than the number of questionnaires returned because many plants employed more than one PM&F process.

As shown in Table IV-2, the type of process with the largest number of wet processes was extrusion followed by cleaning and finishing. After those two types of processes, the number of wet processes varied from 32 for molding to zero for foaming.

Table IV-3 contains a distribution of the number of wet processes by discharge mode. As shown in the table, a large percentage of the wet PM&F processes discharge wastewater to either a publicly owned treatment works (i.e., indirect discharge) or directly to surface waters.

1983 Telephone Survey

In 1983, a two-part telephone survey was conducted to screen the target population for the third questionnaire survey. The first part of the telephone survey consisted of calling:

1. 232 plants that returned a completed 1979 questionnaire;
2. 193 plants that received a questionnaire in 1979 but did not return a completed one; and
3. 734 plants, which is one-half of the PM&F plants that entered the market between January 1, 1978, and December 31, 1981, ("new plants") according to Dun and Bradstreet's list of plants with a primary SIC Code 3079.

The ratio of plants that returned a completed questionnaire in 1979 to those that did not return a completed 1979 questionnaire for the telephone survey (232:193) was the same as the actual ratio of plants that returned a completed 1979 questionnaire to those that did not return a completed questionnaire (407:343). All plants called in the telephone survey were asked whether they were plastics molders and formers and if they use process water in their PM&F processes.

Table VI-4 contains the results of the first part of the telephone survey. As shown in the table, 50 percent of the new plants indicated they use process water. This number was viewed with caution because the Agency believes that many of the respondents did not completely understand the difference between contact and noncontact cooling water.

Table IV-2

SUMMARY OF PLASTICS MOLDING AND FORMING PROCESSES*

Type of Process	Wet Processes	(%)**	Dry Processes	(%)	Total	(%)
Extrusion	323	(71)	129	(29)	452	(100)
Molding	32	(15)	176	(85)	208	(100)
Coating and Laminating	28	(36)	49	(64)	77	(100)
Thermoforming	12	(17)	59	(83)	71	(100)
Calendering	5	(25)	15	(75)	20	(100)
Casting	19	(29)	46	(71)	65	(100)
Foaming	0	(0)	4	(100)	4	(100)
Cleaning and Finishing	137	(88)	18	(12)	155	(100)
TOTAL	556		496		1052	

	Total	%
Wet Process	556	53
Dry Process	496	47
	1052	(100)

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*Based on information from 1979 questionnaire.
**Percent of type of process.

Table IV-3

DISTRIBUTION OF THE NUMBER OF WET PLASTICS MOLDING AND FORMING PROCESSES BY DISCHARGE MODE*

	Discharge Mode								
Type of Process	Direct	(%)**	Indirect	(%)	Zero	(%)	Unknown	(%)	Total
Extrusion	96	(63)	142	(50)	78	(75)	7	(50)	323
Molding	4	(3)	21	(7)	4	(4)	3	(22)	32
Coating and Laminating	1	(1)	19	(7)	5	(5)	2	(14)	27
Thermoforming	3	(2)	6	(2)	3	(3)	0	(0)	12
Calendering	2	(1)	3	(1)	0	(0)	0	(0)	5
Casting	6	(4)	11	(4)	1	(1)	1	(7)	19
Cleaning and Finishing	40	(26)	84	(29)	12	(12)	1	(7)	137
TOTAL	152	(100)	286	(100)	103	(100)	14	(100)	555

*Based on information from 1979 questionnaire.
**Percent of discharge mode.

Table IV-4

RESULTS OF 1983 PLASTICS MOLDING AND FORMING TELEPHONE SURVEY FIRST PART

	Total Number of Plants Contacted	Number of Plants in the PM&F Category	PM&F Plants					
			Wet	(%)	Dry	(%)	Total	(%)
Respondents to the 1979 questionnaire	232	182	182	(100)	0		182	(100)
Non-respondents to the 1979 questionnaire	193	103	29	(28)	74	(72)	103	(100)
New plants listed as entering the market between 1977 and 1981*	734	467	233	(50)	234	(50)	467	(100)

*Based on a listing of plants with a primary SIC of 3079 obtained from Dun and Bradstreet, Inc.

In the second part of the 1983 telephone survey, the other half of the new PM&F plants entered the market between January 1, 1978, and December 31, 1981, (according to Dun and Bradstreet's listing of plants with a primary SIC 3079) were contacted. They were also asked if they were plastics molders and formers and if they use process water. However, they were asked more specific questions, such as what kind of PM&F processes they employ. Since more time was spent asking detailed questions, information from this part of the survey concerning the number of processes that use process water (i.e., wet) and that do not use process water (i.e., dry) is more reliable than similar information from the first part of the survey.

In the second part of the telephone survey, 741 PM&F plants were contacted. Out of that number, 535 plants were plastic molders and formers, while the remaining 206 plants were not. Eighty-four (16 percent) of the 535 PM&F plants had wet processes and 451 (84 percent) had dry processes.

Table VI-5 contains a distribution of the wet and dry processes from the second part of the telephone survey by the type of process. The number of wet processes and the number of dry processes are larger than the number of PM&F plants because some plants had more than one PM&F process. Types of processes with the largest number of wet processes were extrusion, molding, and cleaning and finishing. This corresponds to the types of processes that had the most wet processes in the 1979 detailed questionnaire.

Results of the second part of the telephone survey are distributed by type of wet processes and discharge mode in Table VI-6. Most PM&F processes in the second part of the telephone survey discharged wastewater to POTW's or did not discharge wastewater, (i.e., zero discharge).

Statistics from the 1978 single page questionnaire and the second part of the 1983 phone survey were used to estimate the percentages of wet and dry plants in the PM&F category. These were the only two surveys not directed solely at plants believed to use process water. Of the 5,138 PM&F plants that returned the single page questionnaire in 1978, 21 percent indicated they had wet PM&F processes. This percentage was averaged with the 16 percent of the PM&F plants from the second part of the 1983 telephone survey that had wet processes to obtain an estimate of 18.5 percent of the plants in the PM&F industry that are wet (i.e., use process water). Multiplying that percentage times the estimated 10,260 plants in the PM&F category provides an estimate of 1,898 wet plants in the category.

The total number of 10,260 PM&F plants in the United States was estimated from the State Industrial Guides (Appendix B lists the

Table IV-5

RESULTS OF 1983 PLASTICS MOLDING AND FORMING TELEPHONE SURVEY SECOND PART

Type of Process	Wet Processes	(%)*	Dry Processes	(%)	Total	(%)
Extrusion	52	(48)	57	(52)	109	(100)
Molding	18	(5)	329	(95)	347	(100)
Coating and Laminating	1	(3)	34	(97)	35	(100)
Thermoforming	0	(0)	61	(100)	61	(100)
Calendering	0	(0)	2	(100)	2	(100)
Casting	1	(14)	6	(86)	7	(100)
Foaming	0	(0)	11	(100)	11	(100)
Cleaning and Finishing	14	(16)	74	(84)	88	(100)
TOTAL	86		574		660	

	Total	%
Wet Processes	86	13
Dry Processes	574	87
	660	100

*Percent of individual subcategory.

Table IV-6

DISTRIBUTION OF THE NUMBER OF PLASTICS MOLDING AND FORMING PROCESSES BY DISCHARGE MODE*

Type of Process	% of Total Wet Processes	Discharge Mode Direct	Indirect	Zero	Unknown	Total
Extrusion	60.4	1	15	31	5	52
Molding	20.9	1	7	10	0	18
Coating and Laminating	1.2	0	0	1	0	1
Casting	1.2	0	1	0	0	1
Cleaning and Finishing	16.3	0	4	10	0	14
TOTAL	100.0	2	27	52	5	86

*Based on information from second part of 1983 telephone survey.

guides used to develope this estimate). For the purpose of economic analysis, a sample of PM&F plants was selected from the State Industrial Guides. The sample, created by extracting every 20th plant listed as a producer of SIC 3079 products, formed a data base with 513 entries. Since one of every 20 plants was included, the 513 entries represent five percent of the category. It follows that the PM&F category is comprised of approximately 10,260 plants. (20 x 513 = 10,260). Approximately 77 percent of the 513 randomly selected plants had a primary SIC of 3079 and approximately 23 percent had a secondary SIC of 3079. Applying these percentages to the total number of plants in the PM&F industry yields 7,900 plants that are primary plastics molders and formers and 2,360 that mold and form plastics as a secondary operation. The primary industrial classification of the plants with a secondary plastics molding and forming operation include: textiles, lumber and wood products, printing and publishing, machinery, and transportation equipment.

1983 Questionnaire Survey

To further update the questionnaire data collected in 1978 and 1979 and the telephone survey data collected in 1983, 330 questionnaires were mailed in June 1983 to PM&F plants believed to use process water. The questionnaire sample was developed based on the following criteria:

1. The sample was selected to obtain current information for plants in the category that used process water (wet plants).

2. The sample consisted of "new" PM&F plants (those entering the market between January 1, 1978, and December 31, 1981) and "old" PM&F Plants that use process water.

3. The number of "new" wet plants was based on data obtained through the two-part 1983 telephone survey.

4. The number of "old" wet plants was based on data obtained from the 1979 and 1979 questionnaire surveys and from the first part of the 1983 telephone survey.

All plants entering the market between January 1, 1978, and December 31, 1981, were called during the 1983 two-part telephone survey. Results of that telephone survey indicate that there are 317 new plants that have wet processes.

As previously mentioned, a one-page questionnaire was mailed to 8,450 plants in 1978. There were 1,114 respondents to that questionnaire that indicated they had wet PM&F processes. A more detailed questionnaire was mailed to 750 of the 1,114 respondents in 1979.

Four hundred seven of the plants that received the 1979 detailed questionnaire returned completed questionnaires and 343 did not return completed questionnaires. Applying the percentage of the plants that returned completed questionnaires and the percentage of those that did not return completed questionnaires to the 1,114 wet plants reported in the 1978 one-page questionnaire provides an estimate of the 1,114 plants that would have returned a completed questionnaire and that would not have returned a completed questionnaire if all 1,114 wet plants were mailed a questionnaire. Using those percentages, the Agency estimated that 605 of 1,114 wet plants would have returned a completed questionnaire and 509 would not have returned a completed questionnaire.

To determine the current status of the 750 plants that received the 1979 questionnaire, 425 of those plants were called in 1983. Two hundred thirty-two of the 425 plants returned a questionnaire in 1979 and 193 did not return the questionnaire. The ratio of the plants that were called (i.e., 232:193) is the same ratio of the plants that returned or did not return completed 1979 questionnaires (i.e., 407:343).

Results of this telephone survey indicated that 182 of the 232 plants that returned completed 1979 questionnaires were still in business and had wet PM&F processes. Twenty-nine of the 193 plants that did not return a completed 1979 questionnaire were still in business and had wet PM&F processes.

The estimated number of the 1,114 wet plants from the 1978 questionnaire survey that would have returned a detailed questionnaire (i.e., 605) and the estimated number that would not have returned the questionnaire (i.e., 509) if all 1,114 plants had been mailed a questionnaire in 1979 were adjusted using the results of the above telephone survey. Based on those results, the Agency estimates 475 (605 x 182/232) of the 1,114 wet plants would have returned the questionnaire and 76 (509 x 29/193) would not have returned the questionnaire. Therefore, the target population for the 1983 survey was:

317	new PM&F plants
475	old PM&F plants that would have returned the 1979 questionnaire
76	old PM&F plants that would not have returned the 1979 questionnaire
868	total

The numbers in each of these strata were used to determine the distribution of the 330 detailed questionnaires that were mailed in 1983. That distribution is presented in Table IV-7.

Table IV-7

DISTRIBUTION OF THE 330 1983 QUESTIONNAIRES

Stratum	Target Population	Number of 1983 Questionnaires
New plants	317*	119
Old plants that would have returned 1979 questionnaire	475**	182**
Old plants that would not have returned the 1979 questionnaire	76**	29**

*Based on results of 1983 telephone survey of new plants.

**Based on results of 1983 telephone survey of plants that did and did not return completed questionnaires.

In the 1983 questionnaire survey, companies were requested to return a questionnaire for each plastics molding and forming plant they operated. A total of 346 questionnaires were returned. Of the 346 questionnaires, 324 indicated the plant molds and forms plastic materials. One hundred sixty-four of those plants use process water (i.e., they were wet) and 160 do not use process water (i.e., they are dry). Since 49 percent of the plants do not use process water and the survey was directed at plants who said they did use process water in the first part of the 1983 telephone survey, the Agency's contention that plants did not understand the difference between contact and non-contact cooling water during the first part of the telephone survey is supported.

Most of the plants that received the 1979 and 1983 questionnaires have a primary SIC of 3079, which means that a plant molds and forms plastics as a primary operation. During a meeting with representatives from the Society of Plastics Industries (SPI), they indicated that additional information could be obtained from plants with a secondary SIC of 3079 (i.e., the plant molds and forms plastics as a secondary operation) by sending a questionnaire to a sample of companies on the mailing list for the magazine "Plastic World." Therefore, in August 1983, 170 questionnaires were mailed to companies on that list. As with the other questionnaire surveys, companies were requested to return a questionnaire for each plastics molding and forming plant that they operated, so that a total of 173 questionnaires were returned. Of these, 106 questionnaires indicated the plant molds and forms plastics with 56 plants using process water and 50 plants having dry processes. Because the mailing list included many subscribers not believed to mold or form plastics, such as libraries and chambers of commerce, statistical information from this survey were not used to characterize the PM&F category. However, information from this survey regarding water use practices at plants with wet processes was included in the project data base.

Summary of Questionnaire Data Base

The questionnaire data base for this project consists of questionnaires from both the 1979 and 1983 surveys. When a plant returned a questionnaire in 1979 and again in 1983, only the updated questionnaire from the 1983 survey was included in the data base. Thus, only 196 of the original 332 questionnaires from the 1979 questionnaire survey remain in the updated data base. The data base also contains 212 of the 220 1983 questionnaires returned by wet plants during the 1983 questionnaire survey. The other eight questionnaires were incomplete and it was not possible to obtain additional data through further contact with these plants. Thus, the questionnaire data base consists of 196 questionnaires from the 1979 survey and 212 questionnaires from the 1983 survey for a total of 408 questionnaires.

Each of the questionnaires were reviewed and the following data were documented for future reference and evaluation:

- company name, plant address, and name of the contact listed in the questionnaire.
- plant discharge status (i.e., direct, indirect, or zero discharge).
- production processes present at the plant, as well as associated wastewater flow rates; production rates; operating hours; wastewater treatment, reuse, or disposal methods; and the plastic materials processed.
- capital and annual treatment costs.
- any available pollutant monitoring data provided by the plant.

The summaries provided a consistent, systematic method of evaluating the information. In addition, procedures were developed to simplify subsequent analyses. Using those procedures, information in the data base was used to:

- select and list the plants containing specific production processes and associated types of wastewater and treatment technologies,
- sum the number of plants containing specific processes and associated types of wastewater and treatment combinations,
- calculate the percent recycle for specific flows and sum the number of plants recycling this flow within various percent recycle ranges.
- calculate annual production values associated with each process, and
- calculate water use and wastewater discharge from individual processes.

The survey information was used to develop the category profile, to develop subcategorization schemes, to analyze treatment and control technologies, to determine the water use and discharge values, and to estimate statistics for the estimated 1,898 plants in the PM&F category that use process water. A more detailed description of the combined data base is presented in Section VI.

LITERATURE REVIEW

The literature was examined for information on plastics molding and forming processes and wastewater treatment systems. Treatment system effectiveness and investment and annual treatment system costs were also obtained from the literature.

Many sources were reviewed for information on wastewater treatment technologies. EPA's Innovative and Alternative Technology Assessment Manual provided most of the information on treatment technologies. Treatment technology performance data were obtained from EPA's Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants. Additional data were obtained from documents supporting the proposed organic chemicals, plastics, and synthetic fibers category effluent limitations guidelines and standards. Treatment system information obtained from these sources is presented in Section VIII. Costing information was primarily obtained from EPA's Estimating Water Treatment Costs, and vendor contacts. Details on investment and annual costs are presented in Section IX.

A great variety of general references, texts, and articles were used as sources of information on plastics molding and forming processes. The process descriptions derived from these sources are presented later in this chapter. Process information was supplemented by trip reports of numerous site visits to PM&F plants. A complete list of references used to obtain both process information and information on other aspects of the PM&F category is presented in Section XVI.

INDUSTRY DESCRIPTION

The following description of the PM&F category, and the processes used to mold and form plastic products is based on information from three of the preceding sources of information. The literature provided the foundation on which the descriptions are based. Literature information has been augmented and updated where appropriate by data gathered during the sampling and industry survey efforts.

Plastic materials are a group of synthetic or natural organic materials composed of high molecular weight, long chain molecules. The molecular composition along with the degree of crosslinking and the pattern and amount of branching in the molecule determines the material's characteristics. The generic category of plastic materials includes many types of resins, resinoids, organic polymers, cellulose derivatives, casein derivatives, and proteins. However, except for some specialty applications, the majority of plastic materials used in consumer and industrial products are synthetically produced organic polymers and copolymers.

Plastic materials can be generally classified into two basic groups: thermoplastics and thermosets. Thermoplastics become soft when exposed to a sufficient amount of heat and they harden when cooled. The heating and cooling process can be repeated several times. Thermoplastic materials can be processed by a large number of forming processes, the most common being injection molding and extrusion. They include: acrylonitrile-butadiene-styrene, polyethylenes, polypropylene, polystyrene, and polyvinyl chloride.

Thermosetting plastics are set into their permanent shape when heat and pressure are applied during molding or forming. Unlike thermoplastics, once set into shape, thermoset products cannot be softened and reformed. Thermoset plastic products are usually formed by processes such as compression molding, transfer molding, and casting. Thermoset plastic materials include alkyd resins, nylons, epoxy resins, phenolic resins, and silicon.

Some plastics can be formulated into either thermoplastics or thermosetting products depending on the extent of crosslinking permitted during their manufacture. Once produced, these materials exhibit the properties of the particular type of plastic and are processed accordingly. Polyurethene and polyester are two such plastic materials.

For the purpose of regulation, the plastics industry is covered by two industrial point source categories. These categories are: (1) the organic chemicals, plastics, and synthetic fibers category which includes manufacturers who produce and formulate the basic plastic materials; and (2) the plastics molding and forming category comprised of the processors that convert the plastic materials into usable shapes.

Overlap of the organic chemicals, plastics, and synthetic fibers category and the plastics molding and forming category occurs during the production of crude plastic intermediates, such as pelletized plastic resin. When commonly recognized plastic molding and forming processes such as pelletizing, strand cutting, or film extrusion are used to produce crude plastic intermediates in the final step of a continuous plastic material manufacturing operation before shipment off-site, the processes are regulated under the organic chemicals, plastics, and synthetic fibers category. Plastic molding and forming processes used by plastic resin manufacturers to process plastic materials on-site into intermediate or final plastic products by further molding and forming are controlled by the effluent limitations guidelines and standards for the plastics molding and forming category.

Processes that coat a plastic material onto a substrate may fall within the definition of processes in the electroplating and metal finishing point source categories. For the purpose of regulation, these coating operations are excluded from the effluent limitations guidelines and standards for the electroplating and metal finishing point source categories and are included in the plastics molding and forming point source category.

PM&F plants produce a wide variety of products and range from small plants with a single process and a few employees to large plants with several hundred employees. Plastics molding and forming plants tend to be located near the sales centers of the United States so that finished consumer products need not be transported over long distances. Sixty-five percent of the plants are located in one of the following four clusters:

1. New York, New Jersey, and Pennsylvania;
2. Illinois, Indiana, Michigan, and Ohio;
3. Louisianna, Oklahoma, and Texas; and
4. California and Washington.

PLASTICS MOLDING AND FORMING PROCESSES

The plastics molding and forming category consists of plants that blend, mold, form, or otherwise process a wide variety of plastic materials into intermediate or final plastic products. There are eight generic processes used to process plastic materials. They are:

1. extrusion,
2. molding,
3. coating and laminating,
4. thermoforming,
5. calendering,
6. casting,
7. foaming, and
8. cleaning and finishing.

Each of these processes is described below including discussion of which PM&F processes use process water and the purpose of such use. Process water is defined as any raw, service, recycled, or reused water that contacts the plastic product or contacts shaping equipment surfaces, such as molds and mandrels, that are or have been in contact with the plastic product. Noncontact cooling water is not process water and thus is not controlled by the proposed regulation. Permitting and control authorities will estabish limitations for the discharge of noncontact cooling water and other nonprocess wastewater on a case-by-case basis.

Extrusion Processes

Extrusion processes force molten polymer under pressure through a shaping die to produce products of uniform cross-sectional area such as pipe, tubing, sheet, film, and profile. This process has a number of different applications including the compounding of polymers, the production of pellets and parisons (blow molding preforms) for later use, the production of finished and semi-finished products, and the coating of substrate materials.

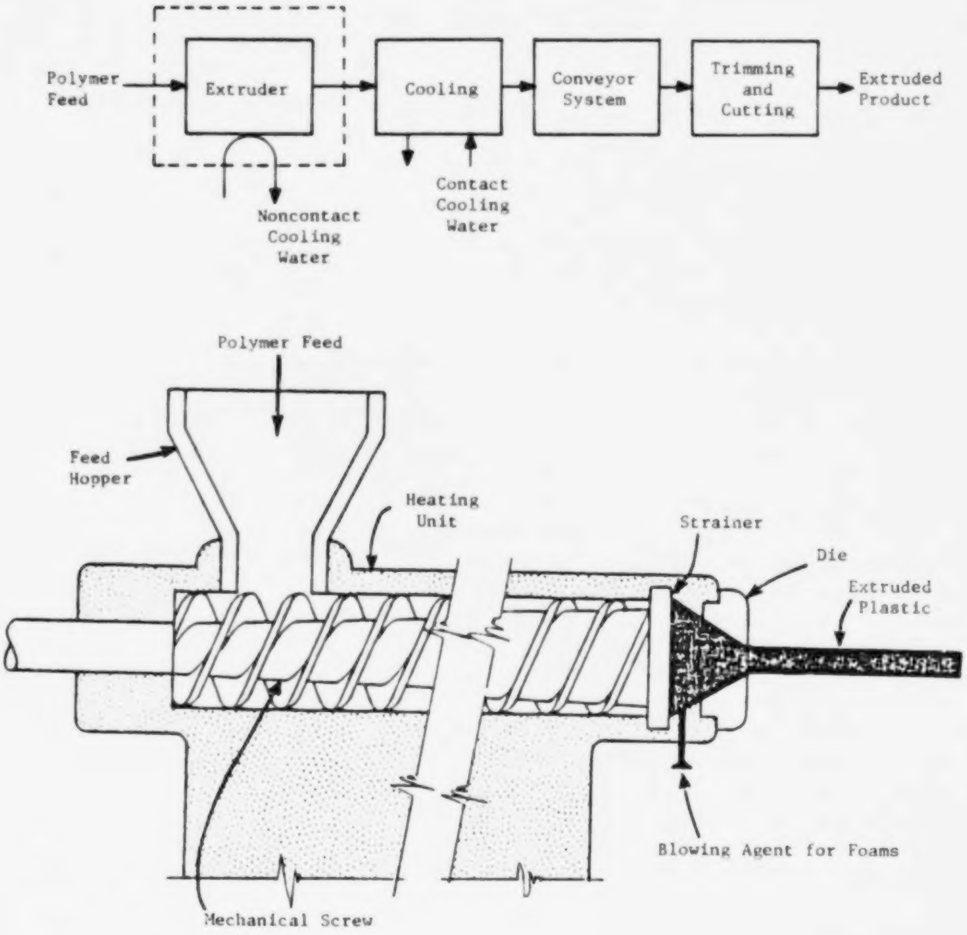
A wide range of polymers are extruded. Thermoplastic polymers are most commonly used and include acrylic resins, acrylonitrile-butadiene-styrene (ABS), polyacetal, fluoroplastics, nylon, polyphenylene oxide, polybutylene, polyethylene, polypropylene, polystyrene, polyvinyl chloride, styrene-acrylonitrile, and thermoplastic polyesters.

Extruded thermoplastic foams are produced by incorporating a gas-forming expanding agent in the thermoplastic and extruding the mixture under carefully controlled conditions. This is an extrusion process with the addition of a blowing agent at the extrusion die. Packaging and building products are the major applications for extruded foam products. The primary raw materials used to produce extruded foam products are acrylonitrile-butadiene-styrene, high density polyethylene, polypropylene, polystyrene, and polyvinyl chloride.

A schematic of the extrusion process is shown in Figure IV-1. Thermoplastic polymer granules, pellets, powder, or beads are fed into the hopper of the extruder. The polymer is picked up by a rotating screw within the extruder cylinder and is forced toward the die. Heat provided to the cylinder walls begins the softening of the polymer pellets. As the material moves along the cylinder, friction becomes the primary source of heat. During this heating and compression period, the plastic material is transformed into a homogeneous melt and is thoroughly mixed.

Prior to leaving the extruder cylinder, the melted polymer passes through a screen pack that removes dirt and provides back pressure control. The melt enters the die at high pressure. The extrusion die is a streamlined orifice that reduces the melt to the desired shape. As the extrudate leaves the extruder, it is transported over some type of roller or conveyor cooling system that cools the hot extrudate by use of air or water.

Approximately 50 percent of extrusion processes use contact cooling water. Contact cooling water is used when a high heat transfer rate is required such as the extrusion of thick-walled products or during pelletizing operations.



Source: Adpated from Masson, D. (ed). The Study of the Plastics Industry. 1973.

Figure IV-1

EXTRUSION PROCESS

Extrusion processes are often used to blend, color, and pelletize thermoplastic polymers. Additives required for special applications and colors desired by the processor are added to the resin and are fed to the extruder to become a homogeneous melt. A brief description of the most commonly used classes of additives and specialty chemicals are presented in Table IV-8. The melt is extruded through a multi-opening die and taken off as strands that are cut into pellets of the desired size after cooling. In many cases, the pellets are cut at the face of the die, which is submerged in water for rapid cooling. Pelletized polymers can be in the form of round, cylindrical, or cube-shaped particles and can be used as feed material for extrusion, molding, casting, foaming, and other processes. Commonly pelletized theromoplastics are ABS, polyethylene, polypropylene, and polyvinyl chloride.

Extrusion processes can use both contact and noncontact cooling water. Noncontact cooling water is used to remove excess heat from the extrusion machinery caused by friction. Direct contact cooling water is used for product quenching. Direct contact cooling water is produced during pelletizing operations when the extruded strands are submerged to facilitate cooling and cutting. Extruded profile, pipe, and tube are often cooled by a cooling water bath. Plastic jacketed wire and cable is also passed through a water trough for direct contact cooling. The use of contact cooling water in extrusion processes is the major use of process water in the plastics molding and forming category.

Molding Processes

Molding is the most common process used to produce finished or semi-finished products from plastic materials. Molded parts can be solid, hollow, or foamed. Plastic objects of almost any desired shape can be produced commercially by one of seven different types of molding processes:

1. injection molding,
2. blow molding,
3. compression molding,
4. transfer molding,
5. reaction injection molding,
6. rotational molding, and
7. expandable bead foam molding.

Injection Molding. Injection molding is used to form intricate plastic parts with excellent dimensional accuracy at very high production rates. Injection molding involves the plasticating of pelletized plastic materials with heat and the subsequent injection of the melt into a mold.

Table IV-8

COMMONLY USED ADDITIVES IN POLYMER FORMULATION USING THE EXTRUSION PROCESS

Additive	Function	Example
Antiblocking Agent	Prevents self-adhesion of films	Silicate minerals High melting point waxes
Antioxidants	Retard oxidative degradation of plastic material during processing and use	Alkylated phenols Amines Phosphates Thio compounds
Antisatic Agents	Reduce the accumulation of electronic charge on the surface of polymers	Amine Quaternary ammonium Anionic surface active agents
Catalysts	Affect the rate of chemical reactions without themselves being consumed or undergoing chemical change	Peroxides Organo-tin compounds Amines
Chemical Resistant Additives	Descrease polymer susceptibility to chemical degradation	Glass Synthetic fibers Graphite
Colorants	Impart hue (shade), volume (brightness), and chroma (strength of color) to plastics	Dyes Organic and inorganic pigments
Coupling Agents	Enhance polymer-mineral surface bonds and increase the ability of composites to retain properties during prolonged exposure to moisture	Silane compounds Titanate compounds
Cure Retardants	Reduce the cure rate for amino resins	Amines
Curing Agents	Improve the curing of thermosetting resins upon exposure to heat	Peroxides Amines Azo compounds
Fibrous Reinforcements	Impart tensile, flexural, and compressive strength to plastics	Synthetic fibers Carbon fibers Glass fibers
Fillers and Extenders	Increase the bulkiness and decrease the total cost of plastic formulations	Calcium carbonate Silica Nutshell flours
Flame Retardants	Act chemically or physically as insulators by creating endothermic cooling reactions, by coating the plastic to exclude oxygen or by influencing combustion through reaction with materials that have different physical properties	Antimony oxide Chlorinated parafins Halogenated organics
Foaming (blowing) Agents	Produce large quantities of gases upon heating that form cellular plastics	Nitrogen Pentane Azo bis formamide
Heat Stabilizers	Prevent the degradation of the plastic material during process heating and during its useful life	Barium-cadmium compounds Tin compounds

Table IV-8 (Continued)

COMMONLY USED ADDITIVES IN POLYMER FORMULATION USING THE EXTRUSION PROCESS

Additive	Function	Example
Impact Resistant Additives	Decrease a plastic materials tendency to break or crack upon impact	Acrylics ABS
Insulators	Improve the thermal or electrical insulating properties of polymers	Silaceous minerals Ceramic oxides
Lubricants	Enhance resin processibility and the appearance of the end product	Fatty acid esters Hydrocarbon oils Paraffin wax Amides
Mold Release Agents	Prevent sticking of newly formed parts to a mold	Silicone Mineral oil Wax Fatty acids Mica Talc
Plasticizers	Impart flexibility, resiliency and increasing melt flow to polymers by reducing the intramolecular forces between polymer chains	Phthalates Adipates Trimellitates Glycolates Fatty acid esters Organic phosphates
Preservatives and Biocides	Inhibit biological degradation of polymers	Fungicides Bacteriostats
Casting Promoters	Improve the cure of cast parts	Cobalt octoate Dimethyl aniline Tin salts
Sizing Agents	Coatings that protect the polymer surface	Waxes
UV Stabilizers	Absorb ultraviolet radiation and reradiate it at a harmless wavelength or consume the free radicals generated by UV light	Benzotriazoles Benzophenones

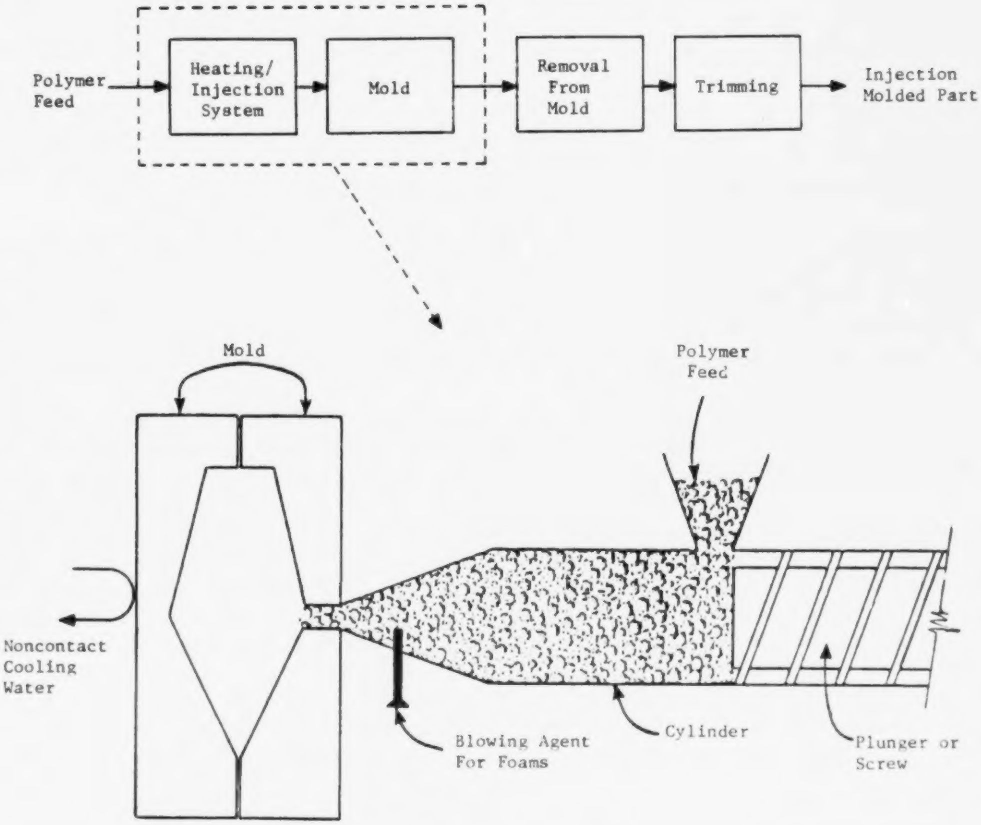
Both thermoplastic and thermoset polymers are injection molded. The majority of injection molded products are produced from polyethylene, polypropylene, polystyrene, and acrylonitrile-butadiene-styrene (ABS). Other polymers that are commercially injection molded are acrylic resins, fluoroplastics, nylons, phenolic resins, polyacetal, polycarbonate, polyesters, polyphenylene sulfide, and styrene-acrylonitrile. Typical injection molded products include appliance parts, furniture parts, machine parts, office and household items, and toys and novelties. Fillers can be added during the injection molding process to produce reinforced plastic products such as appliance components and sporting goods.

A schematic of the injection molding process is shown in Figure IV-2 . The resin and additives are fed into the heating portion of the injection molding machine where the polymer is heated to the temperature at which it becomes soft enough to flow. An injection system forces the melt through a nozzle, then through sprues and runners, and finally into the cavities of the mold where high pressure is held briefly to allow the plastic to set. As thermoplastics cool in the mold, they retain the desired product shape. Thermosets require that heat be applied to the mold to complete polymerization.

Structural foam molding is an injection molding process where a blowing agent is added to either the polymer input materials or the polymer melt. Polystyrene is the major material used in structural foam molding. The following polymers are also used: acrylonitrile-butadiene-styrene, polyphenylene oxide, polycarbonate, high density polyethylene, polypropylene, and polystyrene. Uses for structural foam include furniture, business machines, and construction products.

There are four basic types of heating/injection systems used for commercial injection molding. They are: (1) conventional injection molding machines, (2) piston-type preplasticating machines, (3) screw type preplasticating machines, and (4) reciprocating-screw injection machines. The reciprocating screw injection machine is the most common machine for modern plastics processing due to its faster cycles, lower melting temperature requirements, and better mixing.

In conventional injection molding machines the plastic granules or pellets feed from a hopper into the chamber of the heating cylinder. A plunger compresses the material forcing it through progressively hotter zones of the heating cylinder. The material flows from the heating cylinder through a nozzle and into the mold. In piston-type preplasticating machines a heater is used to preplasticate the plastic granules after which the plastic is held in a holding chamber until it is molten enough to be forced into the die. A piston rams the plastic through the nozzle into



Source: Adpated from Masson, D. (ed). The Study of the Plastics Industry. 1973.

Figure IV-2

INJECTION MOLDING PROCESS

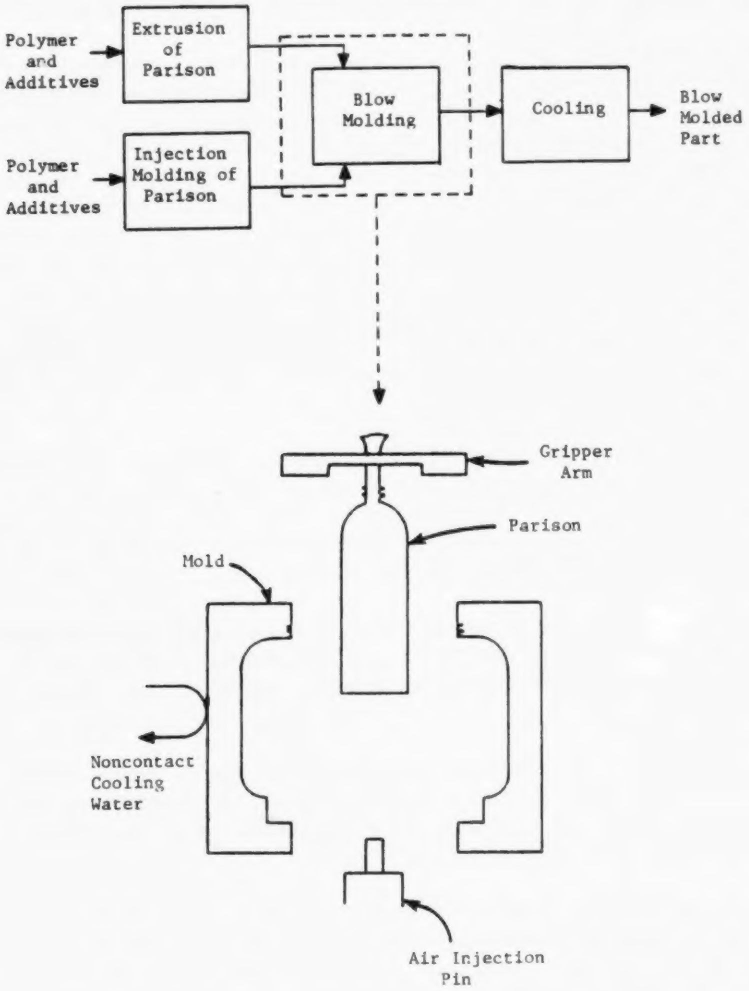
the mold. In screw-type preplasticating machines, an extruder is used to plasticize the plastic material. A rotating screw feeds the pellets forward into the heated interior surface of the extruder barrel. The molten plastic is extruded into a holding chamber and is forced into the die by an injection plunger. In reciprocating screw injection machines, a rotating screw moves the plastic material forward through a heated extruder barrel. As the molten plastic material moves forward, the screw backs up to a limit switch that determines the volume of material collecting in the front of the barrel. The screw then acts as a ram and injects the plastic material into the die.

The majority of all injection molding operations use noncontact cooling water circulated through channels in both the injection equipment and the product mold. Direct contact cooling may be used when molded parts require rapid cooling.

Blow Molding. Blow molding is used to produce hollow, thin wall objects from thermoplastic resins; it has become one of the major processing methods of the plastics industry for hollow articles. Blow molding involves extruding or injection molding a preformed shape that is then blown into its final form by compressed air.

Most thermoplastic materials can be blow molded; however, high density polyethylene has traditionally been the workhorse of the blow molding industry. Other thermoplastic polymers commercially used for blow molding include acrylic resins, acrylonitrile-butadiene-styrene, polyacetal, polycarbonate, polyester, polyethylenes, polypropylene, polystyrene, and polyvinyl chloride. Blow molding processes are used to produce a wide range of hollow bottles and containers. Approximately 80 percent of the blow molding processes produce packaging items. These include household bottles and containers for cosmetics, toiletries, pharmaceuticals, chemicals, and foods, as well as industrial containers. The remaining 20 percent produce industrial products such as automobile fuel tanks, lighting fixture globes, ornaments, and toys.

A schematic of a blow molding process is shown in Figure IV-3. Blow molding processes can be divided into two major types: extrusion blow molding and injection blow molding. These two processes are similar in that they both use a parison, or preshaped sleeve, of plastic that is expanded by air pressure to fill the inside of a concave mold. The difference between the processes lies in the formation of the parison. Extrusion blow molding uses an extruder to preform parisons whereas in injection blow molding the parisons are formed in an injection mold. Blow molding processes use noncontact cooling water to cool the mold.



Source: Adapted from Seymour, W.B. Modern Plastics Technology. 1975.

Figure IV-3

BLOW MOLDING PROCESS

Compression Molding. Compression molding is one of the earliest forms of molding, and requires only one major piece of equipment: the compression press. Compression molding involves shaping a measured quantity of plastic within a mold by applying pressure and heat. This molding process is ideal for the production of parts with large areas and relatively simple shapes.

Compression molding is primarily used for processing thermoset resins, although it is used to mold thermoplastics for special applications. Polymers most commonly used in compression molding include alkyd resins, amino resins, diallyl phthalate, epoxy resins, phenolic resins, and polyester resins. Other less frequently used polymers include polytetrafluorethylene, polyurethane, silicone, and polyvinyl chloride. Fillers such as glass fibers, wood, cotton, and cellulose are often used during compression molding to produce reinforced plastic products. Typical compression molded products include novelties, knobs, handles, dinnerware, buttons, electrical and electronic components, and appliance parts. Reinforced products include large automotive and appliance parts.

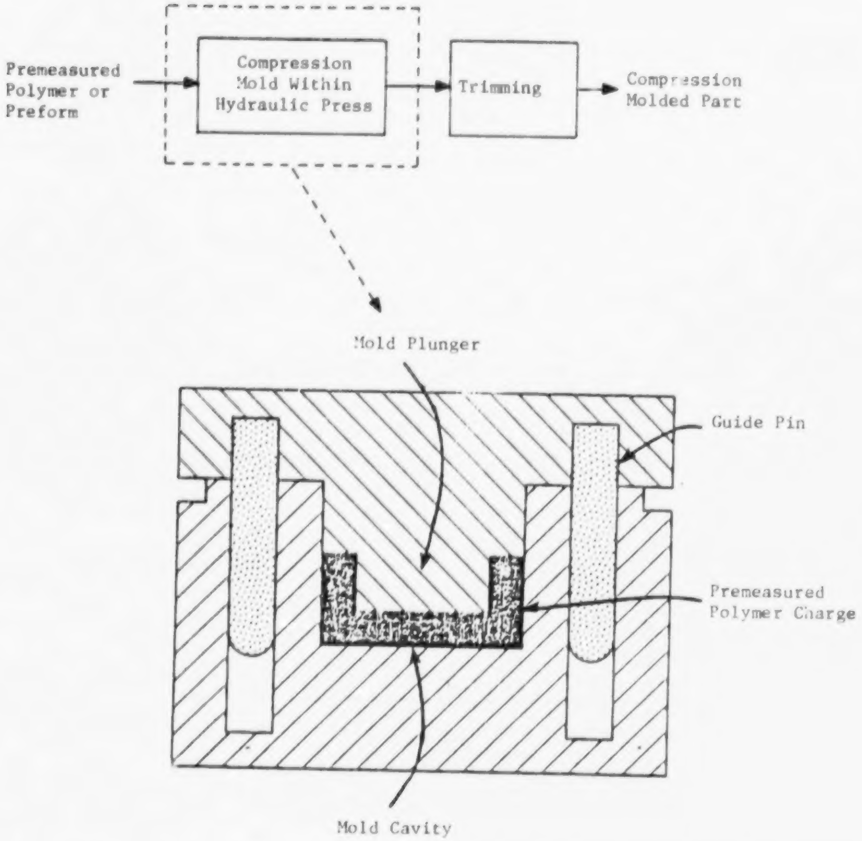
A schematic of the compression molding process is shown in Figure IV-4. The plastic material is fed to the compression mold either in granular form or as a preform. The mold halves are then closed by a hydraulic press. Pressure is maintained and heat is applied, causing the plastic to spread to the shape of the mold.

Compression molding processes generally use noncontact cooling water to cool the mold halves. Some compression molding processes may use contact cooling water sprays to rapidly cool newly formed products.

Transfer Molding. Transfer molding is much like compression molding with the difference being that in transfer molding the resin is preheated in a separate chamber and is then forced into the mold cavity for curing.

Thermoset resins are most commonly transfer molded. These include alkyd resins, amino resins, diallyl phthalate resins, epoxy resins, phenolic resins, and polyester resins. Fillers such as cellulose, clay, glass fiber, minerals, and synthetic fibers are often used during transfer molding to produce reinforced plastic products. Transfer molding is especially well suited for the production of small intricate thermoset parts and is used extensively in the production of electrical insulating parts and connectors. Reinforced products include appliance housings and decorative parts.

A schematic of the transfer molding process is shown in Figure IV-5. Plastic preforms are preheated by heat lamps, hot air ovens, or dielectric heaters. That material is put into a


Premeasured Polymer or Preform
Compression Mold Within Hydraulic Press
Trimming
Compression Molded Part
Mold Plunger
Guide Pin
Premeasured Polymer Charge
Mold Cavity

Source: Adapted from Masson, D. (ed). The Study of the Plastics Industry. 1973.

Figure IV-4

COMPRESSION MOLDING PROCESS

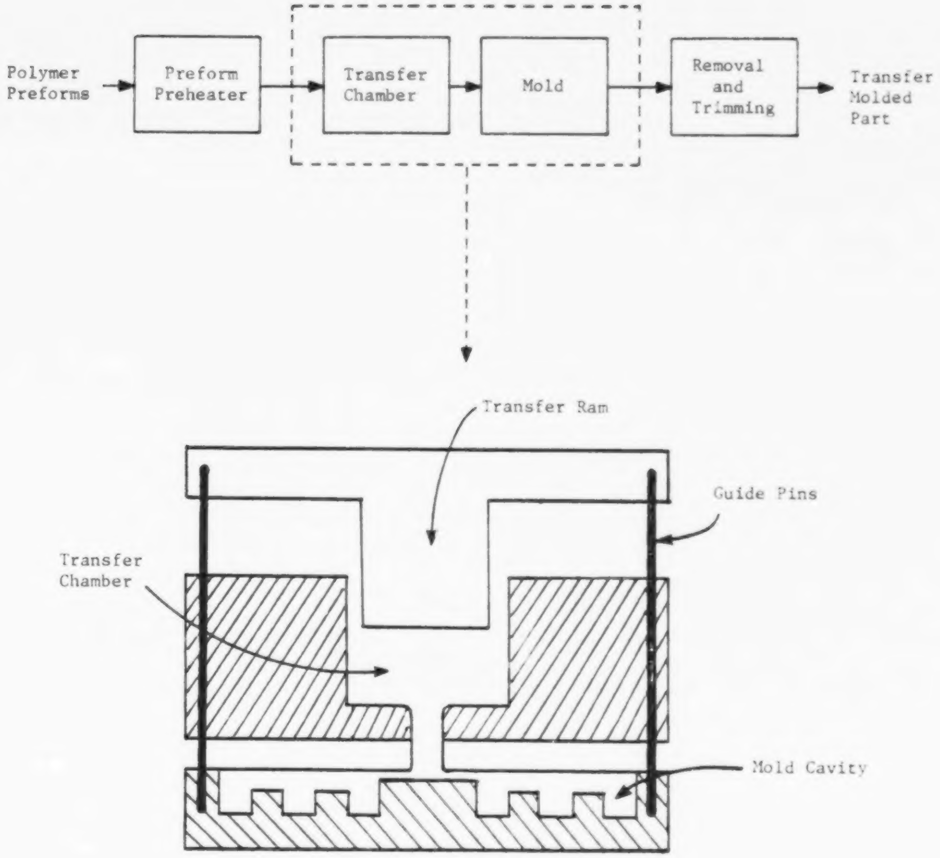


Figure IV-5

TRANSFER MOLDING PROCESS

chamber or "transfer pot" where it is plasticized by heat and pressure into a viscous mass. The plastic is then forced through sprues and runners into the mold cavity. The pot, sprues, runners, and cavity surfaces are maintained at a temperature suitable for rapid curing of the material. The plastic is held in the mold at its cure temperature until the part is capable of maintaining its shape. Transfer molding processes generally do not use contact water to cool the product.

Reaction Injection Molding. Reaction injection molding (RIM) involves the simultaneous high pressure injection of two or more reactive liquids into a mixing chamber followed by low pressure injection into a mold cavity. Most commercial reaction injection molding is performed with various urethane formulations. The majority of urethane formulatons are comprised of two liquid intermediate feeds: the resin and isocyanate. When blowing agents are incorporated in the isocyanate feed, foam products are formed. Fillers are added during reaction injection molding to produce reinforced plastic products for the automotive industry. Reaction injection molded polyurethane products include bumper systems, panelling, automotive trim, sporting goods, and machinery housing.

A schematic of a reaction injection molding process is shown in Figure IV-6. A reaction injection molding process consists of four integrally related units: feed tanks, a metering system, a mixer, and the mold. The feed tanks are where the raw material components are stored and heated. Agitators, heat exchangers, low-pressure pumps, and recirculation equipment are used to maintain liquid temperature and uniformity. Liquid material from the feed tanks are metered to the mixing head where they are mixed under high-pressure. The liquids are then injected into the mold where polymerization occurs. Once the part has sufficiently cured to hold its shape, the mold is opened and the part is ejected. Contact water is not used during the reaction injection molding process. The molded parts can be sufficiently cooled by air.

Rotational Molding. Rotational molding, sometimes termed rotomolding or rotocasting, is used to make rigid or flexible thin-walled hollow objects from thermoplastic materials. Rotational molding involves rotating polymer powder or liquid in a heated hollow mold.

Rotational molding is performed almost exclusively with thermoplastic resins such as polyamide resins, polyacetal, polycarbonate, low density polyethylene, and polyvinyl chloride. The rotational molding process is used to produce a wide range of industrial and consumer goods including arm rests, toys and novelties, sporting goods, and tanks and storage bins.

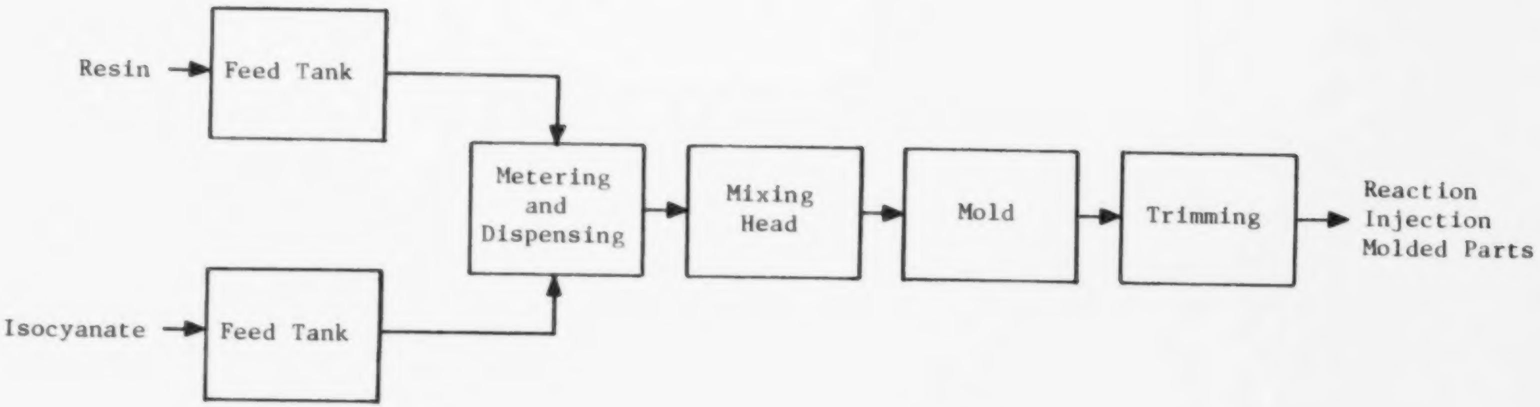


Figure IV-6

REACTION INJECTION MOLDING PROCESS

A schematic of the rotational molding process is shown in Figure IV-7. Premeasured amounts of the polymer powder or liquid are put into the preheated hollow mold at the mold loading station. The mold is then put in the circulating hot air oven where it is simultaneously rotated around two perpendicular axes. The heat forces the thermoplastic to melt and the rotation uniformly distributes the polymer over the entire mold surface. The mold is then removed from the heating oven and is cooled. After the part has cooled sufficiently to hold the desired shape, the mold is opened and the part is removed.

Most rotational molding processes use noncontact cooling water to cool the outside surface of the mold. Some rotational molding processes may use direct contact water sprays when rapid cooling of the part is necessary.

Expandable Bead Foam Molding. Expandable bead foam molding processes produce a closed-cell, rigid plastic foam material characterized by fused polymer spheres. The fused polymer product is produced by expanding beads impregnated with hydrocarbon in a mold cavity. The beads puff and fuse together filling the mold cavity when heated.

Most bead foam molding processes use polystyrene or polyvinyl chloride as raw materials. Typical end products are packaging materials, flotation devices, insulation, and hot and cold containers.

A schematic of an expandable bead foam process is shown in Figure IV-8. Polystyrene beads are usually pre-expanded to a bulk density close to the desired product bulk density prior to further processing. Pre-expansion equipment commonly consists of a steam chamber with baffles and mechanical agitation. Condensate is discharged from the steam chamber.

The pre-expanded beads are fed to a preheated split cavity mold. Steam is supplied to the mold cavity through small holes in the mold. The heat supplied by the steam causes the impregnated beads to expand to fill the confines of the mold. The soft and molten bead skins fuse together to form a single polymer mass. Condensed steam is discharged from the mold cavity.

Water is generally not used for the direct contact cooling of foam products. Noncontact cooling water is used to cool extruder and mold assemblies. However, the steam that heats the product becomes a source of wastewater when condensed.

Coating and Laminating Processes

Coating and laminating processes combine polymeric materials with other materials to produce products with special properties such

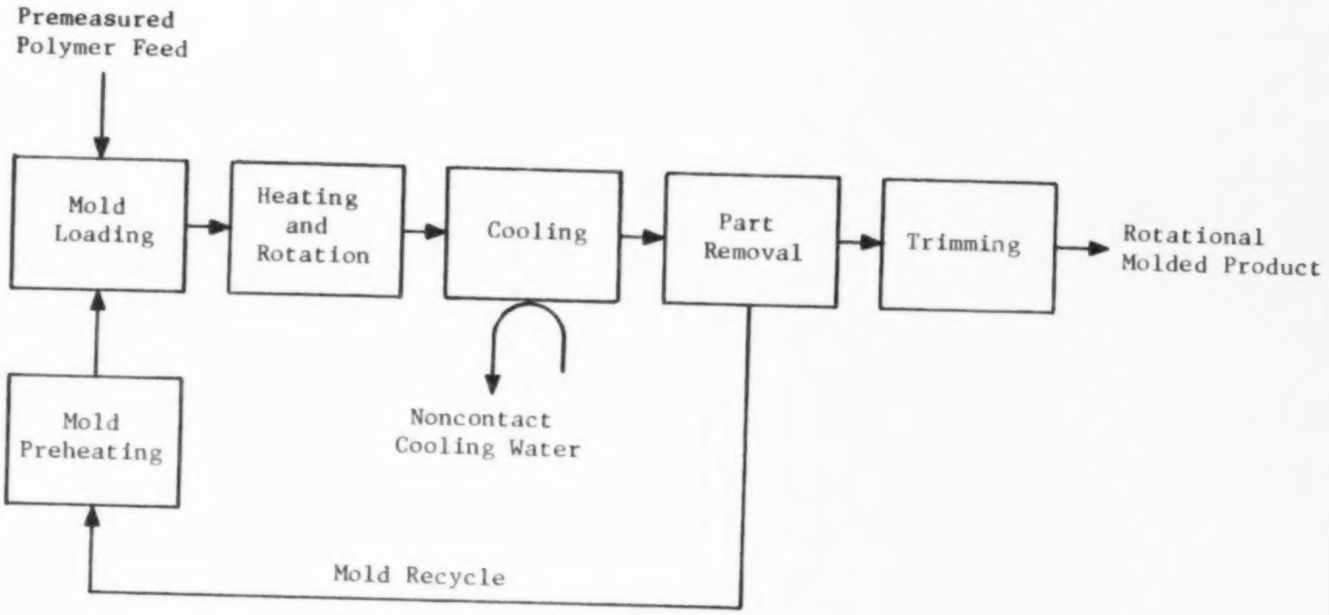


Figure IV-7

ROTATIONAL MOLDING PROCESS

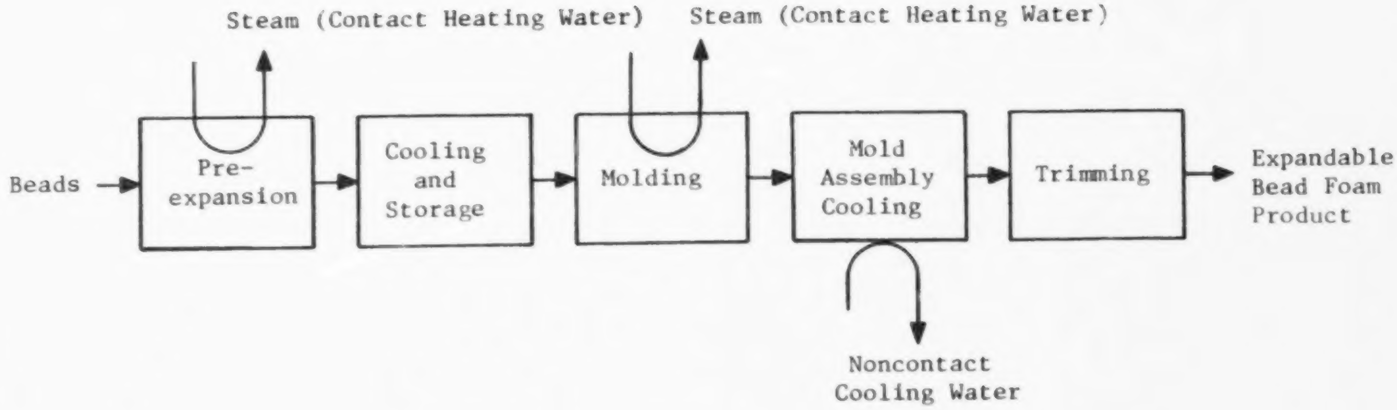


Figure IV-8

EXPANDABLE BEAD FOAM MOLDING PROCESS

as chemical resistance, toughness, humidity resistance, corrosion resistance, and electrical insulation. Heat is used in both processes. Lamination also requires high pressures.

Coating. Polymer coatings are applied in the form of a melt, liquid, or finely divided powder onto numerous substrates including other plastic objects, metal, wood, paper, fabric, leather, glass, concrete, and ceramics. Both thermoplastic and thermoset resins can be coated. The most common resins used are: acrylic resins, epoxy resins, fluoroplastics, amino resins, polyesters, low density polyethylene, polypropylene, and polyvinyl chloride. Typical products from coating processes include automotive parts, appliance parts, electrical supplies, furniture, and housewares.

There are four types of coating processes: plastisol coating, powder coating, spread coating, and extrusion coating. A flow diagram representing plastisol and powder coating is presented in Figure IV-9. Spread coating is illustrated in Figure IV-10. A flow diagram of the extrusion coating process is presented in Figure IV-11.

Plastisol Coating. Plastisol coating involves the use of a liquid plastisol that consists of fine particles of polyvinyl chloride (PVC) dispersed in plasticizers. Typical plastisol coated products include housewares and outdoor furniture. The plastisol is contained in a vat into which the object to be coated is dipped. The objects are sometimes preheated to assure sufficient polymer fusion. The dipped parts then pass through an oven to complete fusion. Some product applications require that the plastisol be applied to the object surface with a spray gun or a brush. Whether sprayed or brushed, the coated object must subsequently be heated in an oven to fuse the polymer coat. The dip coating process is very similar to a dip casting process. The difference lies in the nature of the mold. In dip casting, the plastic part, such as a glove, is stripped from the mold and the mold is used to form another part. In dip coating, the mold is actually part of the finished product, such as a metal patio chair that is dip coated with plastic.

Powder Coating. Powder coating involves the use of a homogeneous blend of thermoset or thermoplastic resin, pigments, fillers, and additives in the form of a dry, fine, flour-like substance. Three basic powder coating methods exist: fluidized bed, electrostatic spray, and electrostatic bed. Fluidized bed coating involves creating a fluidized bed of thermoplastic or thermoset resin powder by the flow of air through a porous plate at the bottom of a tank. Objects to be coated are preheated and are then dipped into the fluidized bed. When the resin particles touch the surface of the hot object they melt and fuse. Electrostatic spraying is performed by charging the polymer powder either positively or negatively so that it is attracted to a

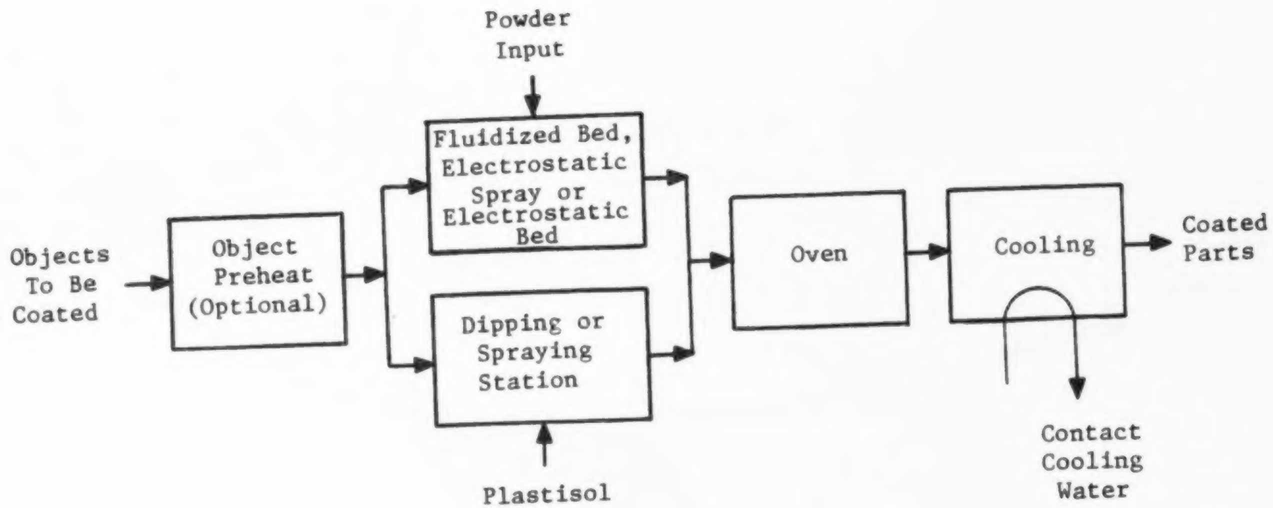

Objects To Be Coated
Object Preheat (Optional)
Powder Input
Fluidized Bed, Electrostatic Spray or Electrostatic Bed
Dipping or Spraying Station
Plastisol
Oven
Cooling
Contact Cooling Water
Coated Parts

Figure IV-9

PLASTISOL AND POWDER COATING PROCESSES

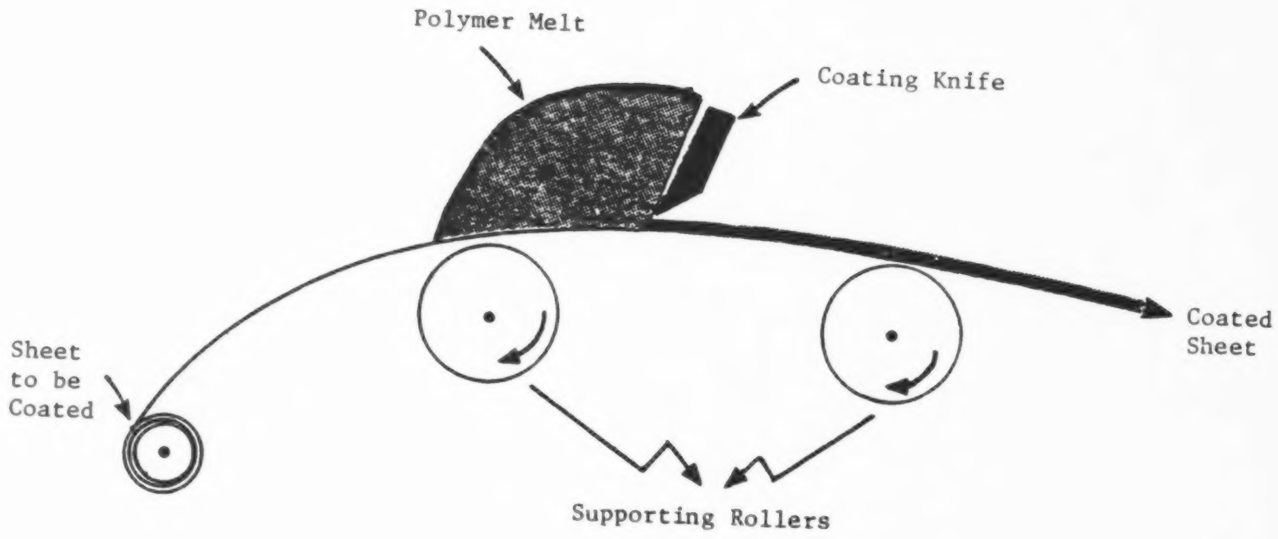


Figure IV-10

SPREAD COATING PROCESS

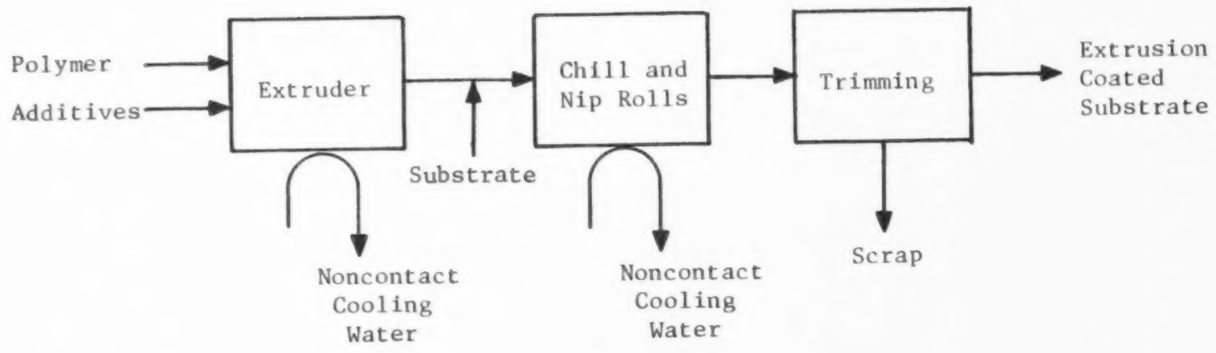


Figure IV-11

EXTRUSION COATING PROCESS

grounded or oppositely charged object. The electrostatic bed process is a combination of the fluidized bed and electrostatic spray methods. Electrodes located in the porous plate at the bottom of the fluidized bed tank transfer a charge to the powder particles which are then attracted to the grounded object to be coated.

Spread Coating. Knife or spread coating uses a long blade or knife to spread the molten thermoplastic polymer coating on a moving substrate. Thermoplastics such as low density polyethylene, polyvinyl chloride, and polypropylene are used to coat flexible materials such as fabric.

Extrusion Coating. Extrusion coating involves the extrusion of a thin layer of polymer onto a moving substrate, which is usually either a paper web, plastic sheet, or paper sheet. Polymers such as low density polyethylene, polypropylene, and polyethylene terephthalate are used in extrusion coating processes to produce the coatings.

Direct contact cooling water is often used to cool newly coated parts, particularly when the plastisol coating or powder coating process has been used to produce the plastic covering.

Laminating. Laminate structures are formed from layers of resins and fillers bonded together. Thermosetting resins are the only resin types commercially used for laminating. Typical laminating resins include alkyd resins, epoxy resins, melamine formaldehyde, and phenolic resins. Paper, cloth, glass fiber, and glass cloth are typically used as the reinforcing substrate. Lamination processes are used to produce decorative panels and items requiring good electrical insulating properties. Process water is typically not used in lamination processes.

Laminating processes can be classified into three types: lamination of flat sheets, lamination of rods and tubes, and continuous lamination. A schematic of the laminating process is shown in Figure IV-12.

Flat Sheet Lamination. Flat laminate sheets are produced by impreganting the base sheets with liquid thermosetting resin. Phenolics, melamines, alkyd, polyester, and epoxies are all commonly used. The correct number of sheets for the specific application are placed together with the resin between two platens of a hydraulic laminating press. The hydraulic press closes and pressure and heat are applied to the layers. The thermoset resin flows through the filler sheets and cures. After the sheets have sufficiently cured, the platens are allowed to cool, the press is opened, and the sheets removed.

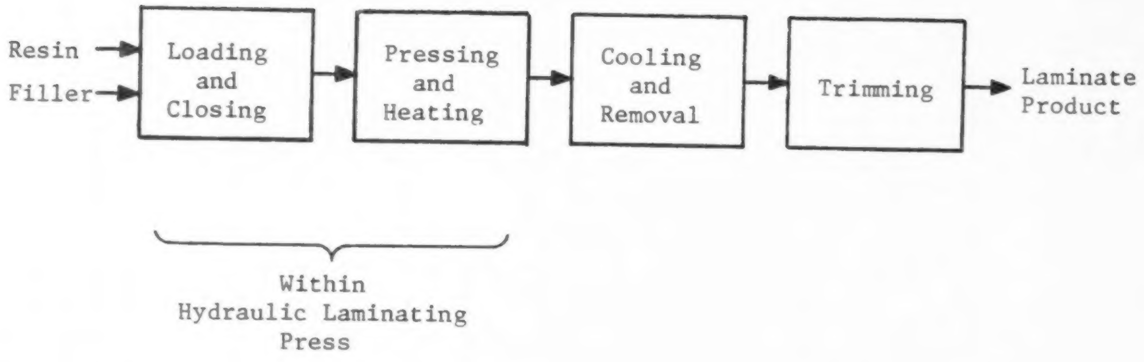


Figure IV-12

LAMINATING PROCESS

Rod and Tube Lamination. Laminate rods and tubes are produced from filler webs impregnated with thermoset resin. Solid rods are made by winding the impregnated filler web around a very thin rod (mandrel) which is then withdrawn. The preform rods are then placed in a compression mold where heat and pressure are applied. In some operations the rods are placed in an oven and allowed to cure without pressure over a long period of time, typically 12 to 24 hours. In making a tube, the mandrel is left in during the compression molding step.

Continuous Lamination. Continuous lamination processes are used to produce large volumes of structural grade sheets for use as residential and industrial panels. Polyester resins are most commonly used in the continuous lamination process along with chopped glass fibers. Continuous lamination is performed by combining the resins and reinforcements between two moving carrier films. The films are pulled through a set of squeeze rolls to eliminate entrapped air. The laminate cures in an oven after which the carrier film is stripped from the newly formed laminate. Figure IV-13 depicts the continuous lamination process.

Thermoforming Processes

Thermoforming processes involve the heating of thermoplastic sheet or film to a pliable state and forcing it around the contours of a mold. Vacuum, air pressure, and/or mechanical force are employed to aid in the sheet forming. The input for thermoforming processes is foam sheet or film produced by extrusion, calendering, or casting processes. Sheet and film can be laminated or printed prior to thermoforming.

A wide variety of sheet and film plastic is suitable for thermoforming. Sheet and film for thermoforming is typically made from acrylic, acrylonitrile-butadiene-styrene, polycarbonate, polyethylenes, polypropylene, polystyrene, and polyvinyl chloride. Typical thermoformed products include appliance parts, automotive parts, lighting fixtures, packaging, and signs and displays.

A schematic of thermoforming processes is shown in Figure IV-14. Plastic sheet is clamped into a frame prior to thermoforming to provide support for the plastic material throughout the entire process. The plastic sheet is uniformly heated before being formed to be certain of uniform stretch during forming. One of three heating methods are usually used: radiant heating, convection heating, and conduction heating, with radiant heating being the most commonly used method. When sufficiently heated, the sheet is formed into the desired shape by one of three forming processes: (1) vacuum forming, (2) pressure forming, and (3) matched mold forming.

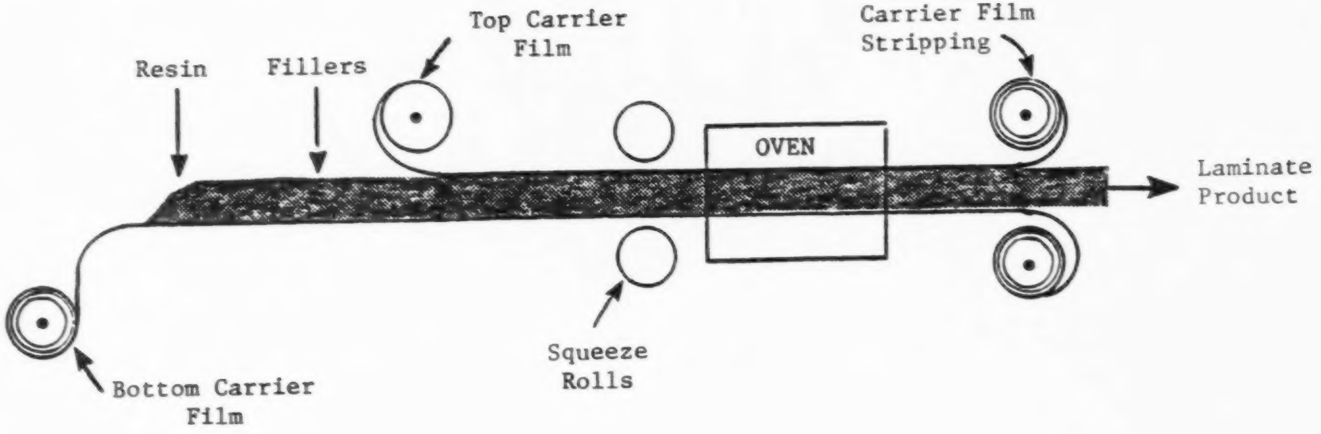
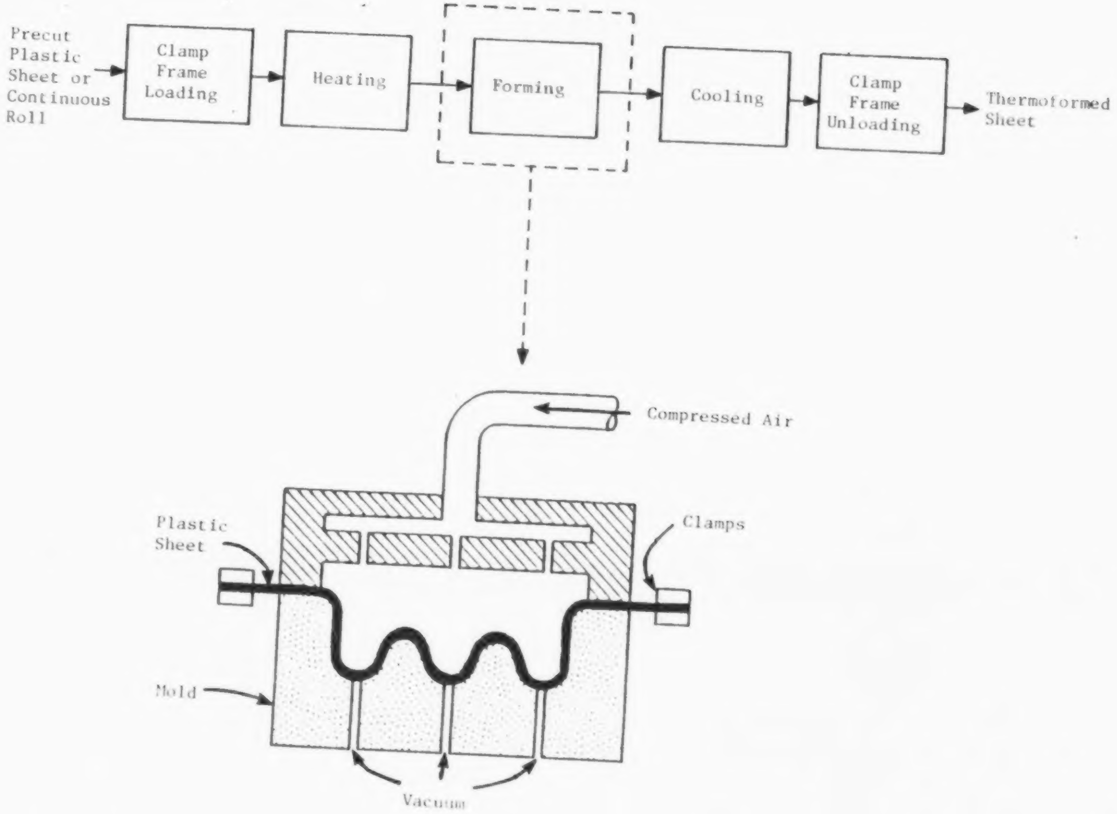


Figure IV-13

CONTINUOUS LAMINATION PROCESS



Source: Adapted from Masson, D. (ed). The Study of the Plastics Industry. 1973.

Figure IV-14

THERMOFORMING PROCESS

Vacuum Forming. Vacuum forming is the most versatile and most commonly used process for thermoforming. The heated sheet is placed directly above a concave mold and pressure is used to seal the plastic material to the upper mold edge. Vacuum is applied from beneath the mold through small holes in the mold cavity forcing the sheet against the mold contours. Although many variations of vacuum forming exist, they all employ a vacuum applied from below the mold surface. Common variations are termed drape forming, snap-back forming, and plug assist vacuum forming.

Pressure Forming. Pressure forming involves the use of air pressure to force the softened plastic sheet against the mold. A sheet of plastic is clamped over a pressure box containing a concave mold and is heated. The sheet is then covered and compressed air is blown through openings in the cover. The air pressure forces the sheet against the mold contours. A variation of pressure forming termed free blowing is used to produce bubble-like forms.

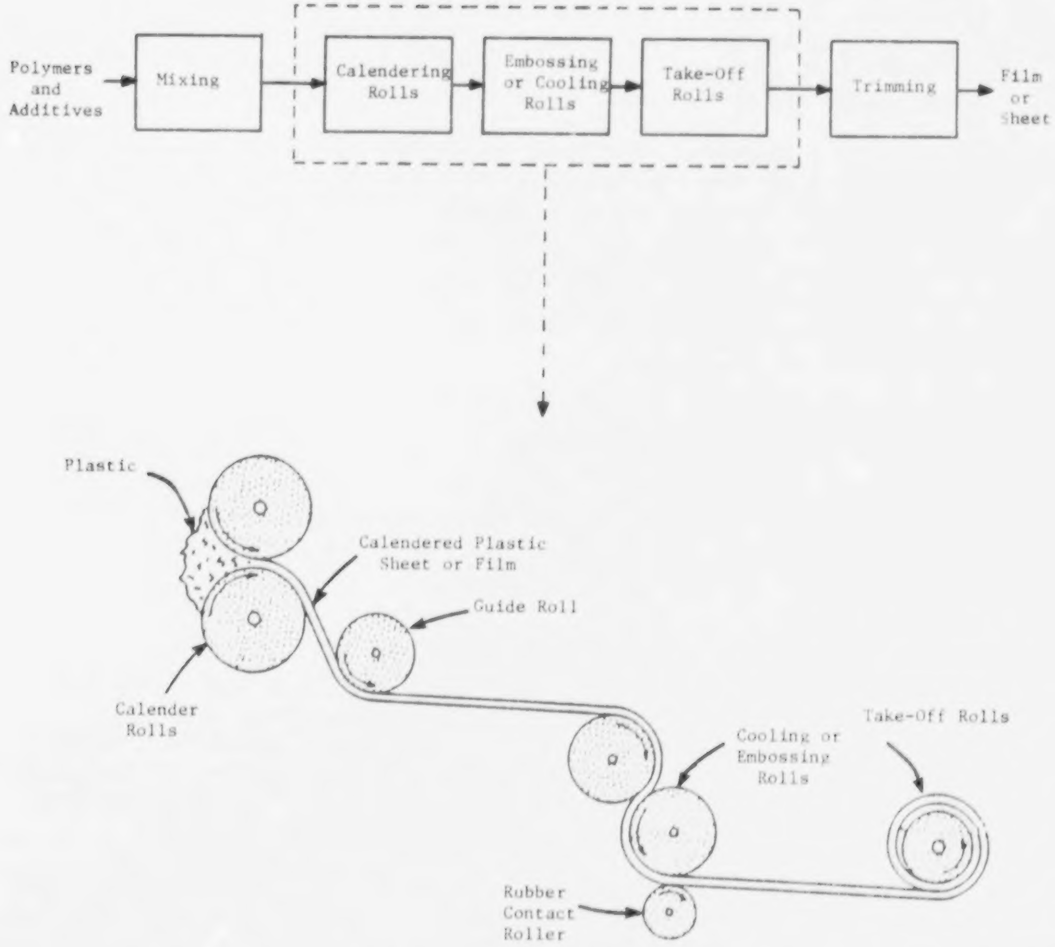
Matched Mold Forming. Matched mold forming is used to produce products requiring excellent reproduction detail. The heated sheet material is placed between convex and concave mold halves. The halves are brought together, thereby forming the sheet into the mold shape. Most thermoforming processes use noncontact cooling water. However, in some instances, the thermoformed product may be spray cooled with water.

Calendering Processes

Calendering is widely used in the plastics molding and forming category to produce uniform thickness film and sheet at high production rates. Calendering processes squeeze pliable thermoplastic between a series of rotating rolls to produce the polymer film and sheet, to emboss sheet and film, to perform compounding and to coat textiles and papers.

Flexible and rigid polyvinyl chloride compounds are the most commonly used input materials for the manufacture of calendered products. Typical products include building and construction supplies, packaging supplies, and consumer and institutional goods such as toys, seats, and coverings. Acrylonitrile-butadiene-styrene, polyethylene, and polystyrene are also used to produce various films.

A schematic of a calendering process is shown in Figure IV-15. Calendering processes generally consist of five units: mixing, calendering, cooling, take-off, and trimming. The thermoplastic resin and the appropriate additives are transferred from storage facilities through a sieve to a high shear mixer or mill where heat is supplied to soften and blend the polymer mix. The polymer is then fed to the calendering unit, which is usually



Source: Adapted from Masson, D. (ed). The Study of the Plastics Industry. 1973.

Figure IV-15

CALENDERING PROCESS

comprised of three to five heated cast iron rolls that squeeze the softened polymer into a sheet or film of desired width and thickness. The arrangement of the calender rolls is determined by the product requirements as are the number of rolls and the roll spacings. The clearance between rolls is progressively decreased to slowly reduce the thickness and increase the width of the sheet or film. Most roll arrangements are adjustable to allow versatility in production methods. Newly calendered sheet is cooled by feeding the sheet or film through a series of two to to ten cooling rolls cooled with noncontact cooling water. The take-off rolls feed the sheet and film to edge trimming operations, further finishing operations, or roll-up.

Calendering is also used to coat materials such as paper and fabric with a polymer. The process is similar to that described above except that fabric or paper is fed into the calendering rolls as the plastic film is formed. The plastic and fabric are tightly bonded together by the heat and force of the rolls and emerge from the cooling rolls as a single composite sheet.

Most calendering processes use noncontact water to cool the cooling rolls. Contact cooling water may be used to cool the rubber contact roller when embossing is performed. Some calendering processes may also use contact cooling water to cool the newly formed sheet or film.

Casting Processes

In the plastics molding and forming category, the term casting is used rather loosely to describe a wide variety of processes. Casting involves liquid plastic materials allowed to cure at atmospheric pressure in a mold or on a mold surface.

Both thermoplastic and thermoset resins can be used in casting processes. Commonly cast thermoplastics include acrylics, nylons, and polyvinyl chlorides. Commonly cast thermosets include epoxy resins, polyesters, phenolics, and polyurethanes.

Fillers are often used in casting processes to produce reinforced plastic products such as boats and recreational vehicles, troughs, ducts, bins and tubs, as well as preforms for use in the compression molding of reinforced products.

There are six types of casting processes: pot casting, slush and dip casting, cell casting, chilled film casting, solvent casting, and continuous casting. A schematic of pot, slush and dip, cell, solvent, and continuous casting processes is shown in Figure IV-16. The chilled film casting process is illustrated in Figure IV-17.

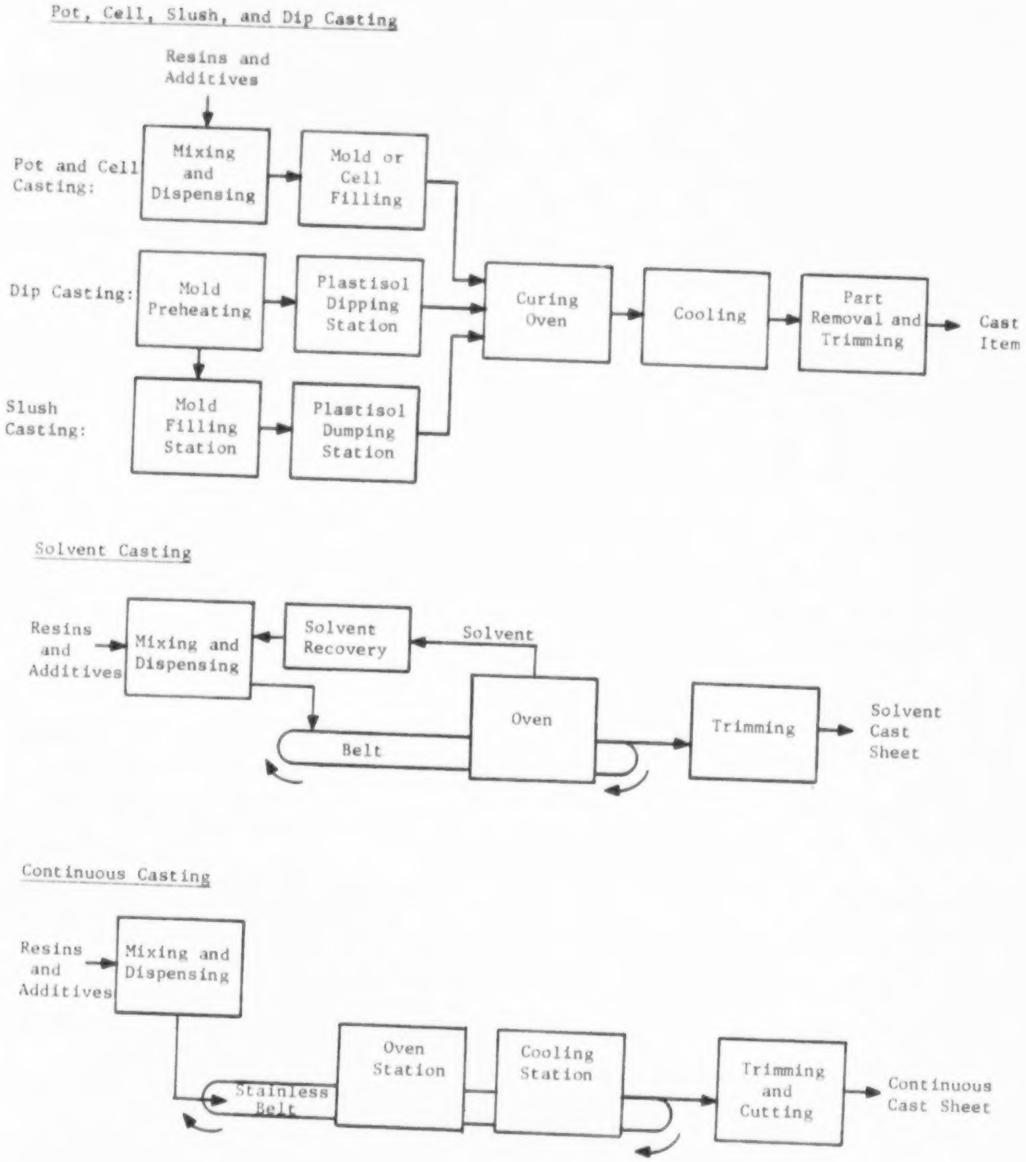


Figure IV-16

CASTING PROCESSES

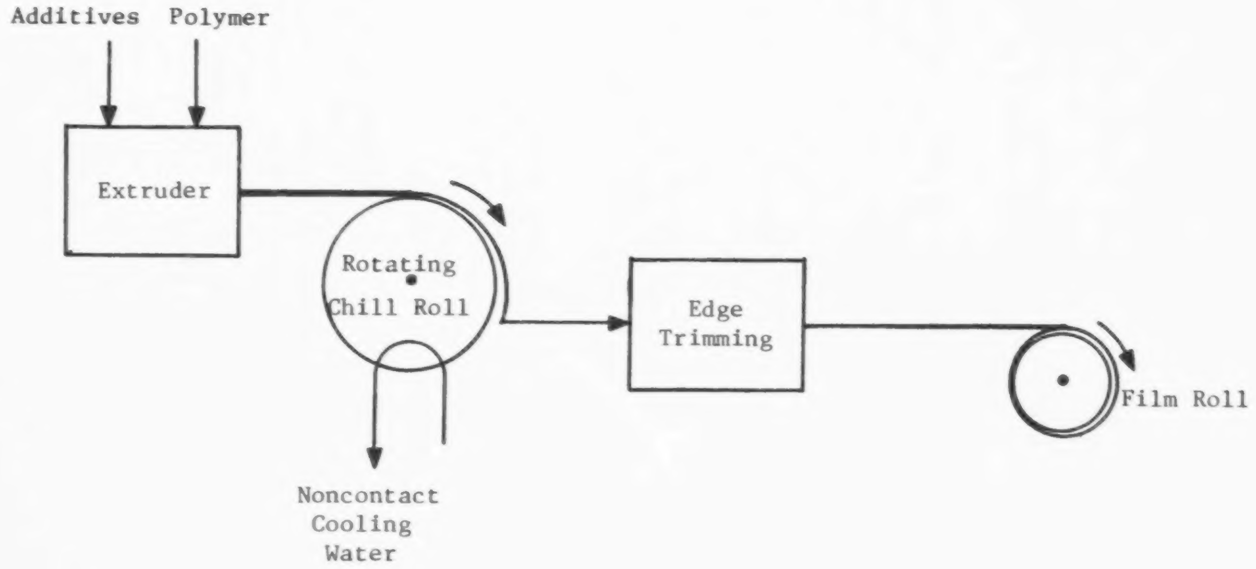


Figure IV-17

CHILLED FILM CASTING PROCESS

Pot Casting. Pot casting is the simplest form of casting and is used to produce a wide variety of products. Polymers used in pot casting include acrylic, alkyl resins, diallyl phthalate, epoxy, nylon, phenolic, polyester, polyurethane, and silicone elastomer. During pot casting a liquid polymer or a monomer solution is poured into an open mold where is it allowed to cure. The pot cast part is cured by the addition of heat in an oven, exothermically by means of a catalyst, or by a combination of both methods. Typical pot cast products include novelties, plaques, knobs, embedments, electrical encapsulations, optical products, bearings, gears, jewelry, billiard balls, seals and gaskets, housewares, and furniture parts.

Slush and Dip Casting. Slush and dip casting involve the use of liquid plastisol (fine particle polyvinyl chloride dispersed in plasticizers such as dioctyl phthalate). These plastisols are viscous at room temperature. In slush casting, a measured amount of plastisol is poured into a hollow mold that has been preheated. The mold is rotated quickly to cover all inside surfaces and after a specific period of time, excess plastisol is poured out into a storage vat for future reuse. The thickness of the hollow part is determined by the amount of time the plastisol remains in the mold. The mold is then placed in an oven and is heated for several minutes to complete fusion. Typical slush cast products include housewares, novelties, doll heads, fish lures, and toys.

In dip casting, a mold is preheated and dipped into the liquid plastisol. A polymer coating fuses around the mold during immersion. The coated mold is then placed in an oven to complete fusion. Typical dip cast products include novelties, boots, gloves, coin purses, and eye glass cases.

Cell Casting. Cell casting is used to produce sheet, tubes, and rods. Acrylic sheet is most commonly cell cast. A premeasured amount of liquid acrylic, consisting of a small amount of polymer in a monomer and additive solution is poured between two sheets of polished or tempered plate glass that are slightly larger than the desired acrylic sheet product. The glass cell, which is held together by tubing and spring clips, is then placed horizontally in an oven for curing.

Chilled Film Casting. Chilled film casting is a casting process used to produce non-oriented, thin, polymer films. Thermoplastic materials such as polypropylene homopolymer, propylene-ethylene copolymer, and low density polyethylene are most commonly used to produce film. The most common form of chilled film casting is termed chill roll casting. In chill roll casting, the formulated polymer is extruded through a slot die onto a rotating, chilled, polished roll. The movement of the roll draws the molten resin away from the die without significantly stretching or orienting the film. The extrudate solidifies into a film as it passes over the chilled roll surface. The film is trimmed as necessary and wound onto rolls. Chill casting processes produce high clarity film products. Process water is not used during chill roll casting.

A less commonly used film casting process is termed tubular water bath casting. A thin-walled vertical tube of formulated polymer is extruded downward from a rotating circular die over a water cooled mandrel. The tube is quenched in contact cooling water and split open to form a film. The film is then trimmed and wound on rolls.

Solvent Casting. Solvent casting, often referred to as solution casting, is used for the production of film and sheet. Polyvinyl chloride (PVC) organosols are the most commonly used polymers for this process. Organosols are formed by dispersing finely powdered PVC in plasticizer and organic solvents. The solution is poured onto a rotating drum or an endless belt that passes through an oven. The solvent is evaporated in the oven in carefully programmed heat zones and a relatively solvent-free polymer film leaves the oven.

Continuous Casting. Continuous casting processes produce thin continuous acrylic sheet. It is very similar to cell casting except that the liquid acrylic is cured between two highly polished moving stainless steel belts. The acrylic, trapped between the stainless belts, travels through the oven and air cooling stations.

Water may be used for the direct contact cooling of cast products. Direct contact cooling water sprays can be used in slush and dip casting processes and in some pot casting processes. During tubular water bath casting, direct contact cooling water can be used during a product quenching step.

Foam Processes

Foamed plastics (often called cellular or expanded plastics) are made by adding a blowing agent to thermoplastics or thermosets to form a spongelike material. Blowing agents are either added to the input material and vaporize due to heat or are generated as a by-product of a cure reaction. Plastic foam products have wide commercial use for flotation devices, packaging, cushioning, and insulation. Plastic foams can be either rigid or flexible. Foamed plastic products can be classified into one of three types: extruded theromplastic foam, structural foam, and multi-component thermoset foam. The production of extruded thermoplastic foams is a variation of the extrusion process where either dry chemicals that foam when heated are included in the resin feed or a solvent blowing agent is injected into the polymer melt at the extrusion die. Structural foam molding is a variation of the injectin molding process where chemical blowing agents or injected gases form bubbles in the molded product. Multicomponent thermoset foams are formed in a carefully controlled reaction injection molding (RIM) process where blowing agents are either generated as a by-product of the chemical reaction that takes place in the mold of a RIM process or added with the input materials and vaporized by the heat of reaction.

Cleaning and Finishing Processes

Parts produced by the various molding and forming processes may require cleaning and finishing to become useful end products.

Cleaning. Cleaning processes consist of washing plastic parts to remove residual mold release agents and other matter prior to finishing, shipping, or further processing. Washing is generally divided into two segments; a detergent wash cycle and a rinse cycle for the removal of detergents and other foreign matter. Cleaning is usually performed in a batch mode and direct contact wastewater is produced. Parts may be cleaned in a washing machine that operates cyclicly. In the first cycle parts are washed with detergent water, in subsequent cycles the parts are rinsed. When the wash-rinse cycle is complete the parts are removed from the machine and the whole process is repeated with new parts. The other type of cleaning process is a continuous, staged process. The parts to be cleaned are conveyed through a detergent wash stage and then through a rinse stage. Shaping equipment such as molds may also be washed in a cleaning process.

Finishing. Finishing processes are performed to render the plastic products useful. There are three general finishing processes: machining, decorating, and assembling. Machining is used to drill, cut, mill, and otherwise shape products to match final product specifications. Decorative finishes are applied to plastic parts by a variety of methods including painting, printing, hot stamping, and vacuum metallizing. Assembling involves joining two or more plastic parts by methods such as solvent welding, ultrasonic welding, and electronic heat sealing. Process water is often used in finishing processes as a lubricant and carrier of waste particulates generated by the finishing process.

SECTION V

SUBCATEGORIZATION

BASIS FOR SUBCATEGORIZATION SCHEME

In developing regulations for the plastics molding and forming category, the Agency considered whether different effluent limitations guidelines and standards are appropriate for different segments of the industry. The Act allows EPA to consider a number of factors to determine if subcategorization is needed. These factors are:

1. raw materials,
2. production processes,
3. products,
4. size and age of plants,
5. geographic location,
6. types of water use, and
7. wastewater characteristics.

The Agency determined whether any of these individual factors identified a need to subcategorize the PM&F category. The Agency also evaluated the relationship between different factors to identify a need for subcategorization. A discussion of each factor is presented below. After considering all these factors, the Agency determined that the plastics molding and forming category is most appropriately regulated using two subcategories.

FACTORS CONSIDERED

Raw Materials

The raw materials used in the plastics molding and forming category can be classified as:

- plastics and resins,
- chemical additives, and
- processing aids.

The type and combination of raw materials used in plastics molding and forming are highly dependent on the production process used and the end products desired. Plastics molders and formers can use many different raw material combinations to produce different end products at one production plant over a given period of time. Many different raw materials may also be used in any one type of PM&F process.

The concentration of pollutants in PM&F wastewater varies because of the raw materials used. However, the types of pollutants in these wastewaters are similar regardless of the material processed. Therefore, a subcategorization based on raw materials is not needed to ensure equitable effluent limitations guidelines and standards for the PM&F category. Further, due to the proprietary nature of the raw material combinations and the variability of the end products, the Agency believes that a subcategorization scheme based on raw materials is not feasible for the PM&F category.

Production Processes

There are eight different generic production processes used in the plastics molding and forming category. They are:

1. extrusion,
2. molding,
3. coating and laminating,
4. thermoforming,
5. calendering,
6. casting,
7. foaming, and
8. cleaning and finishing.

Each of the above processes uses process water (i.e., water that contacts the plastic product). Process water is used in the first seven processes to cool or heat plastic materials and plastic products. Process water is used in cleaning and finishing processes to clean plastic products, to clean shaping equipment, and to finish plastic products.

Data indicate that the wastewater discharged from contact cooling and heating processes and from cleaning and finishing processes is similar regardless of the process used to process the product. Further, the volume of process water needed to cool or heat plastic materials and products and to clean or finish plastic products is largely dependent on the amount of plastic material processed rather than the type of process in which the plastic material is processed. For these reasons, the Agency does not believe that a subcategorization scheme based on type of process is appropriate or necessary to ensure equitable effluent limitations guidelines and standards for the PM&F category.

Products Produced

An extremely wide range of products are produced in the plastics molding and forming category. The products can be classified according to the following types:

1. packaging materials,
2. building and construction components,
3. consumer and institutional products
4. electrical and electronics products,
5. appliances,
6. transportation products,
7. furniture,
8. industrial equipment, and
9. intermediate products.

Products within any given product type can generally be manufactured from several different plastic materials and in several different production processes. In addition, any given plant may produce a wide range of products falling into many of the above product types. The volume of water used to cool or heat and to clean or finish the various types of products and the amount or type of wastewater pollutants discharged by those processes is not dependent on the type of product produced. Thus, a subcategorization scheme based on product type is not feasible for the PM&F category and does not appear to be necessary from a technical viewpoint.

Size and Age of Plants

The plastics molding and forming industry is a relatively new industry that developed following the development of the polymer and resins formulating industry. To remain competitive in an industry that has steadily made technological improvements over the past 30 years, PM&F plants have been continually modernized. Thus, since most PM&F plants were built in the same general time frame and are continually modernized, neither plant age nor equipment age is a significant factor that requires subcategorization to ensure equitable effluent limitations guidelines and standards.

The number of employees and amount of production can be used to measure relative sizes of PM&F plants. However, neither factor provides an adequate basis for subcategorization.

The amount of wastewater discharged and the types of pollutants in the wastewater are largely independent of the number of plant employees. Variations in staff occur for many reasons including shift differences, the need for clerical and administrative support, the need for maintenance support, efficiency of plant operations, and market fluctuations. Due to these and other factors, the number of employees is constantly fluctuating, making it difficult to develop a correlation between the number of employees and the amount of wastewater generated.

While plant production can be used to approximate the mass of pollutants generated, the Agency has determined that it should not be used to establish different effluent limitations guidelines and standards for the plastics molding and forming category for the following reasons:

1. The types of PM&F processes used and the characteristics of the wastewater discharged from those processes are not dependent on the total plant production.
2. While the amount of production affects the total mass of pollutants discharged it has little effect on the types and range of concentrations of pollutants found in the wastewater. Therefore, there is little, if any, difference between the type of treatment technology required at small and large PM&F plants where process water is treated and discharged.

Geographic Location

Plastics molding and forming plants are not limited to any one geographical location and are generally located near distribution and sales centers so that the finished products need not be transported over long distances. A large percentage of molding and forming plants are located in the four geographical clusters of (1) New Jersey, New York, and Pennsylvania; (2) Illinois, Indiana, Michigan, and Ohio; (3) Louisiana, Oklahoma, and Texas; and (4) California and Washington.

There are no specific geographical factors that significantly affect water use at PM&F plants or characteristics of PM&F wastewater. The physical space required for the treatment systems evaluated is small compared to the overall plant size. Therefore, there are no consequences from the construction and operation of a wastewater treatment system peculiar to the different geographical areas. Therefore, it is not reasonable to subcategorize the PM&F category based on geographic location.

Types of Water Use

Results of the questionnaire surveys and the sampling programs for this project indicate that there are basically two types of wastewater generated by processes in the PM&F category. They are:

1. contact cooling and heating water, and
2. cleaning and finishing water.

Contact cooling and heating water is used to either cool or heat plastic materials or plastic products. Water can be sprayed onto a product or the product can be drawn through a water bath. In either case, the volume of water needed for cooling or heating is dependent on the amount of plastic material processed (i.e., the amount that has to be cooled).

Cleaning and finishing water is used to clean plastic products, to clean shaping equipment, or to finish plastic products. Cleaning water includes water used in the washing and rinsing cycles of a cleaning process. Finishing water includes water used to carry away waste plastic materials during a finishing process and to lubricate a plastic product during finishing.

Wastewater is also generated by the solvent recovery operation in the solution or solvent casting process. However, this wastewater does not result from the blending, molding, forming, or any processing of the plastic material and is not a process water. The Agency believes that solvent recovery wastewater is best controlled on a case-by-case basis by the permit writer or control authority. Solvent recovery wastewater is discussed further in Section VI.

Information obtained from the questionnaire surveys indicate that contact cooling and heating water and cleaning and finishing water are handled differently when those process waters are recycled. The different recycle methods could influence the equitable application of effluent limitations guidelines and standards based on flow reduction by recycle. For this reason, the type of water use was considered further as the basis for the PM&F subcategorization scheme.

Wastewater Characteristics

Results of the sampling programs for this project indicate that contact cooling and heating water and cleaning and finishing water contain similar pollutants. However, the concentration of those pollutants vary. This variation in pollutant concentration is not expected to influence the technology used to treat those waters.

However, the characteristics of the wastewater do influence the type of recycle unit used to recycle contact cooling and heating water and cleaning and finishing water. In particular, the high suspended solids concentration in cleaning and finishing water requires that those concentrations be reduced before the process water is recycled. This means that recycle units used to recycle contact cooling and heating water, which has a low suspended solids concentration, may not be used to recycle cleaning and finishing water. Because the recycle method could influence the equitable application of effluent limitations guidelines and standards based on flow reduction by recycle, wastewater characteristics were considered further as the basis for the PM&F subcategorization scheme.

SELECTED SUBCATEGORIZATION SCHEME

The subcategorization scheme for the PM&F category is based on the types of water use and wastewater characteristics. Both of these factors influence the type of unit used to recycle contact cooling and heating wastewater and cleaning and finishing process water. This can influence the volume of wastewater discharged by processes in the PM&F category. Therefore, the equitable application of effluent limitations guidelines and standards based on recycle may be influenced by the type of water use and the characteristics of the wastewater.

The two subcategories for the PM&F category are based on the type of water use and wastewater characteristics. They are:

1. contact cooling and heating water subcategory, and
2. cleaning and finishing water subcategory.

The contact cooling and heating water subcategory includes those processes where process water contacts raw materials or plastics products for the purpose of heat transfer during plastics molding and forming. In identifying model treatment technology options for this subcategory, the Agency found that further subdivision based on average process water usage flow rate was required. Thus, processes with an average process water usage flow rate of 35 gpm or less are in one subdivision and processes with an average process water usage flow rate greater than 35 gpm are in a different subdivision. Further discussion of the flow cut-off for this subcategory is presented in Section X of this development document.

Some molding and forming processes (e.g., extrusion and pelletizing) are used by plastic resin manufacturers to process crude intermediate plastic material. For the purpose of this regulation, plastic molding and forming processes used by plastic resin manufacturers to process crude intermediate plastic materials for shipment off-site are excluded from this regulation and regulated under the organic chemicals, plastics, and synthetic fibers category. Plastic molding and forming processes used by plastic resin manufacturers to process plastic materials on-site into intermediate or final plastic products by further molding and forming are controlled by the proposed effluent limitations guidelines and standards for the PM&F category.

In several instances, particular PM&F processes and the wastewater generated by these processes may fall within this and other industrial categories for which the Agency has established effluent limitations guidelines and standards. Thus, for the purpose of regulatory coverage, the Agency has separated each process to insure that it is clearly subject to one set of effluent limitations guidelines and standards. Processes that coat a plastic material onto a substrate may fall within the definition of electroplating and metal finishing as defined in 40 CFR Parts 413 and 433 (see 48 FR 32485; July 15, 1983). These coating operations are excluded from the effluent limitations guidelines and standards for the electroplating and metal finishing point source category and are included in the PM&F category.

Coating of plastic material onto a formed metal substrate is also covered by the PM&F effluent limitations guidelines and standards and is not covered by the specific metal forming effluent limitations guidelines such as those for aluminum forming, copper forming, and nonferrous metals forming. However, the PM&F regulation applies only to the coating process; the prior forming operations are subject to the specific metal forming regulation.

Plants in the PM&F category may have processes generating only one type of wastewater and thus fit within one subcategory. However, many plants generate both contact cooling and heating water and cleaning and finishing water. In this instance, plants must comply with the effluent limitations guidelines and standards for both subcategories.

One advantage of this subcategorization scheme is that plants can easily identify the types of water used in their PM&F processes. Having only two subcategories should also make it less complicated for the permit writer to write permits for PM&F plants.

The following sections of this development document present sampling data, effluent limitations guidelines and standards, and other information based on this subcategorization scheme.

SECTION VI

WATER USE AND WASTEWATER CHARACTERISTICS

This section discusses the water use and wastewater discharge practices for the PM&F category and presents the wastewater treatment technologies currently used by PM&F plants. Data used to characterize PM&F wastewater are also presented in this section. The data were obtained from two sources:

1. questionnaires, and
2. sampling and analysis programs.

QUESTIONNAIRE DATA

From the survey data base for this project described in Section IV, statistics were developed to apply to the plastics molding and forming plants that use process water. The data base contains questionnaires from 408 plants: 196 questionnaires are from the 1979 survey and 212 questionnaires are from the 1983 survey.

The 408 questionnaires were reviewed and summarized to determine the discharge mode (i.e., direct, indirect, or zero discharge) for the wastewater generated by PM&F processes. Table VI-1 contains a distribution of the 542 wet processes reported in the questionnaires by discharge mode for the types of wastewater generated. As shown in the table, 31 percent of these processes are direct dischargers, 44 percent are indirect dischargers, and 25 percent have no discharge.

Table VI-2 presents average production, average operating hours, average water use, and the number of processes with recycle by process water usage flow range for the various discharge modes. To obtain this information, the production rate, the process water usage flow rate, the operating hours per year, recycle information, and the discharge mode were listed for each process in the data base by plant identification code. These data were then segregated by discharge mode and listed in ascending order of liters of water used per hour. The process water usage flow ranges were selected and the average production rates, the average water used and the average operating hours were calculated by summing the parameters for all processes in a flow range and dividing the sum by the number of processes in that flow range. This information is presented for both contact cooling and heating water and cleaning and finishing water.

Table VI-3 distributes the average wastewater discharged by flow range for the direct and indirect dischargers. There are a different number of processes in the process water usage flow ranges

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Table VI-1

DISCHARGE MODE FOR WET PROCESSES IN QUESTIONNAIRE DATA BASE*

Type of Wastewater	Discharge Mode							
	Direct	(%)**	Indirect	(%)	Zero	(%)	Total	(%)
Contact Cooling and Heating Water	144	(32)	183	(41)	121	(27)	448	(100)
Cleaning and Finishing Water	26	(28)	57	(60)	11	(12)	94	(100)
TOTAL	170	(31)	240	(44)	132	(25)	542	(100)

*Based on information from 1979 and 1983 questionnaire surveys.

**Percent for type of wastewater.

Table VI-2

WATER USE DATA*

Contact Cooling and Heating Water Subcategory

Direct Dischargers

Process Water Usage Flow Range (gpm)	Number of Processes	% of Processes in Flow Range	Average Plastic Production (kkg/yr)	Average Operating Hours per Year	Average Water Use (l/hr)	Number of Processes With Recycle
$X < 0.3$	7	4.9	1,696	5,494	30	2
$0.3 < X \leq 2$	9	6.3	715	5,742	189	1
$2 < X \leq 8$	24	16.7	3,703	5,819	913	2
$8 < X \leq 20$	35	24.3	5,971	5,496	3,130	7
$20 < X \leq 50$	30	20.8	3,921	5,678	7,640	8
$50 < X \leq 100$	17	11.8	9,558	6,500	16,400	8
$100 < X \leq 200$	8	5.5	8,602	5,660	33,200	3
$200 < X \leq 300$	6	4.2	9,582	8,247	62,000	4
$300 < X$	8	5.5	21,447	7,176	352,000	7
TOTAL	144	100				42

Indirect Dischargers

Process Water Usage Flow Range (gpm)	Number of Processes	% of Processes in Flow Range	Average Plastic Production (kkg/yr)	Average Operating Hours per Year	Average Water Use (l/hr)	Number of Processes With Recycle
$X < 0.3$	19	10.4	827	3,946	28	1
$0.3 < X \leq 2$	36	19.7	1,597	3,854	210	2
$2 < X \leq 8$	36	19.7	2,332	4,244	1,000	6
$8 < X \leq 20$	41	22.4	2,202	4,978	3,120	9
$20 < X \leq 50$	11	6.0	1,466	4,025	6,860	3
$50 < X \leq 100$	15	8.2	3,197	5,589	17,900	8
$100 < X \leq 200$	7	3.8	4,047	6,442	41,500	6
$200 < X \leq 300$	6	3.3	5,119	6,134	55,300	3
$300 < X$	12	6.5	9,926	6,722	149,000	12
TOTAL	183	100				50

Zero Dischargers

Process Water Usage Flow Range (gpm)	Number of Processes	% of Processes in Flow Range	Average Plastic Production (kkg/yr)	Average Operating Hours per Year	Average Water Use (l/hr)	Number of Processes With Recycle
$X < 0.3$	10	8.3	127	5,047	18	2
$0.3 < X \leq 2$	16	13.2	2,495	4,139	273	10
$2 < X \leq 8$	28	23.1	2,576	5,937	971	25
$8 < X \leq 20$	17	14.0	1,119	4,483	3,690	15
$20 < X \leq 50$	22	18.2	2,842	4,554	7,470	19
$50 < X \leq 100$	8	6.6	2,053	5,481	17,300	8
$100 < X \leq 200$	3	2.5	1,803	5,567	30,100	3
$200 < X \leq 300$	6	5.0	9,985	5,422	54,700	5
$300 < X$	11	9.1	9,781	6,837	159,000	11
TOTAL	121	100				98

*Based on information obtained from the 1979 and 1983 questionnaire surveys.

Table VI-2 (Continued)

WATER USE DATA*

Cleaning and Finishing Water Subcategory

Direct Dischargers

Process Water Usage Flow Range (gpm)	Number of Processes	% of Processes in Flow Range	Average Plastic Production (kkg/yr)	Average Operating Hours per Year	Average Water Use (l/hr)	Number of Processes With Recycle
X < 0.3	3	11.54	7,279	5,685	13	0
0.3 < X ≤ 2	6	23.07	849	4,956	227	0
2 < X ≤ 8	5	19.23	730	6,138	944	0
8 < X ≤ 20	4	15.38	5,961	5,441	2,920	0
20 < X ≤ 50	5	19.23	290	3,944	9,590	1
50 < X ≤ 100	1	3.85	486	4,160	11,600	0
100 < X ≤ 200	1	3.85	3,686	8,000	40,200	0
200 < X ≤ 300	1	3.85	2,226	6,000	50,000	1
300 < X	0	0	0	0	0	0
TOTAL	26	100				2

Indirect Dischargers

Process Water Usage Flow Range (gpm)	Number of Processes	% of Processes in Flow Range	Average Plastic Production (kkg/yr)	Average Operating Hours per Year	Average Water Use (l/hr)	Number of Processes With Recycle
X < 0.3	13	22.8	251	4,106	16	0
0.3 < X ≤ 2	12	21.0	987	4,897	290	0
2 < X ≤ 8	14	24.5	606	3,172	1,010	1
8 < X ≤ 20	6	10.5	4,232	3,737	2,700	0
20 < X ≤ 50	3	5.3	1,250	2,517	5,430	0
50 < X ≤ 100	3	5.3	2,879	5,739	15,500	0
100 < X ≤ 200	1	1.8	40	3,894	23,400	1
200 < X ≤ 300	1	1.8	85.8	2,144	52,000	1
300 < X	4	7.0	2,412	3,840	89,100	4
TOTAL	57	100				7

Zero Dischargers

Process Water Usage Flow Range (gpm)	Number of Processes	% of Processes in Flow Range	Average Plastic Production (kkg/yr)	Average Operating Hours per Year	Average Water Use (l/hr)	Number of Processes With Recycle
X < 0.3	2	18.2	88	1,940	34	1
0.3 < X ≤ 2	3	27.3	3,623	6,380	189	1
2 < X ≤ 8	2	18.2	2,780	5,320	1,470	1
8 < X ≤ 20	1	9.0	64	192	4,530	0
20 < X ≤ 50	0	0	0	0	0	0
50 < X ≤ 100	0	0	0	0	0	0
100 < X ≤ 200	0	0	0	0	0	0
200 < X ≤ 300	0	0	0	0	0	0
300 < X	3	27.3	802	5,250	114,000	3
TOTAL	11	100				6

*Based on information obtained from the 1979 and 1983 questionnaire surveys.

and the wastewater discharged flow ranges because a process in a process water usage flow range with a recycle unit could have a discharge flow rate in a different flow range. To calculate the average wastewater discharged, the processes were listed in ascending order of liters of wastewater discharged per hour by discharge mode. In each discharge flow range, the liters of water discharged per hour for each process were summed and the sum was divided by the number of processes in the discharge flow range to calculate the average wastewater discharged. Similarly, the average operating hours per year were calculated for those processes in the wastewater discharge flow ranges and are presented in Table VI-3.

Table VI-4 contains a distribution of the number of wet processes in the questionnaire data base that have no discharge by the method used to obtain no discharge. As shown in the table, most of the processes with no discharge have 100 percent recycle of the wastewater.

The 408 questionnaires were also reviewed to determine the treatment technologies currently used by plants in the PM&F category. A summary of those treatment technologies is presented in Table VI-5. The 23 plants listed in the table are plants where a significant portion (i.e., 50 percent or more) of the wastewater treated is from PM&F processes. Only 12 of those plants have treatment technologies that treat only PM&F wastewater. The other plants have integrated treatment technologies that treat wastewater from PM&F processes with wastewater from other industrial processes. The 23 plants where a significant portion of the wastewater treated is from PM&F processes are only six percent of the plants in the data base. The other 94 percent of the plants are zero dischargers or had no treatment technology or are plants where more than 50 percent of the wastewater treated was discharged by processes other than PM&F processes.

Of the 542 wet PM&F processes in the combined data base, 205 recycle process water. Table VI-6 contains a distribution of the number of processes that recycle wastewater by discharge mode. As shown in the table, 51 percent of those processes do not discharge wastewater, 21 percent are direct dischargers, and 28 percent are indirect dischargers.

PM&F CATEGORY DATA

The 408 plants in the questionnaire data base are distributed with respect to the processes that use a specific type of process water in the following manner:

(1) 332 plants (81.4 percent) have processes using only contact cooling and heating water,

Table VI-3

WASTEWATER DISCHARGE DATA*

Contact Cooling and Heating Water Subcategory

Discharge Flow Range (gpm)	Direct Dischargers			Indirect Dischargers		
	Number of Processes**	Avg. Operating Hours per Year	Avg. Water Discharged (l/hr)	Number of Processes	Avg. Operating Hours per Year	Avg. Water Discharged (l/hr)
$X < 0.3$	17	5,326	17	34	4,037	24
$0.3 < X \le 2$	18	6,291	277	45	4,666	215
$2 < X \le 8$	32	6,181	1,020	41	4,743	953
$8 < X \le 20$	32	5,778	3,200	37	5,154	3,090
$20 < X \le 50$	25	5,564	7,490	14	4,570	7,840
$50 < X \le 100$	11	7,058	17,100	7	5,506	18,900
$100 < X \le 200$	6	4,914	29,100	2	4,195	41,300
$200 < X \le 300$	1	8,000	54,500	3	5,998	61,300
$300 < X$	2	7,228	80,900	0	0	0
TOTAL	144			183		

Cleaning and Finishing Water Subcategory

Discharge Flow Range (gpm)	Direct Dischargers			Indirect Dischargers		
	Number of Processes**	Avg. Operating Hours per Year	Avg. Water Discharged (l/hr)	Number of Processes	Avg. Operating Hours per Year	Avg. Water Discharged (l/hr)
$X < 0.3$	3	5,685	12	17	3,994	24
$0.3 < X \le 2$	6	4,956	227	15	4,552	292
$2 < X \le 8$	6	5,915	883	14	3,192	865
$8 < X \le 20$	4	5,441	2,920	6	3,738	2,680
$20 < X \le 50$	5	4,184	8,650	3	2,517	5,430
$50 < X \le 100$	1	4,160	11,600	2	7,152	14,300
$100 < X \le 200$	1	8,000	40,200	0	0	0
$200 < X \le 300$	0	0	0	0	0	0
$300 < X$	0	0	0	0	0	0
TOTAL	26			57		

*Based on information for processes in questionnaire data base.

**The number of processes in a discharge flow range may be different than the number of processes in the same flow range for water usage because some processes recycle process water. This reduces the amount of wastewater discharged.

Table VI-4

DISTRIBUTION OF NUMBER OF PROCESSES IN QUESTIONNAIRE DATA BASE WITH ZERO DISCHARGE*

Zero Discharge Method	Contact Cooling and Heating Water	Cleaning and Finishing Water
100 Percent Recycle	89	2
Ponded for Evaporation	5	2
Septic Tank with Leach Field	10	2
Evaporation from Process Equipment	7	1
Land Application	10	0
Contract Haul	0	2
TOTAL	121	9

*Based on information from 1979 and 1983 questionnaire surveys.

Table VI-5

PM&F TREATMENT TECHNOLOGIES SUMMARY*

Plant ID	Discharge Mode	% PM&F Waste-water	pH Adjustment	Equalization	Oil Skimming	Solids Skimming	Filtration	Aeration	API Separator	Clarifier	Settling Basin	Chlorinator	Activated Sludge	Carbon Adsorption	Coagulant Addition	Gravity Thickener	Vacuum Filter	Sludge or Solids Removal
			Treatment Technologies															
640	Direct	100			X	X	X				X							
405108A	Direct	100			X	X												
602195C	Direct	100							X									
564076A	Direct	100	X								X							
1400	Direct	99						X			X							
958218R	Direct	97	X	X						X					X	X	X	X
958218U	Direct	95	X					X		X	X							X
1420	Direct	88		X			X	X				X						X
1946	Direct	86	X								X							
29640A	Direct	81									X							
362544S	Direct	80					X	X			X							
580294E	Direct	61						X			X							
1330	Direct	50	X	X		X	X			X			X	X				X
721018	Indirect	100	X				X				X							
580294B	Indirect	100			X													
958218Q	Indirect	100	X															
1500	Indirect	100	X								X							X
2722	Indirect	100	X												X			
10650	Indirect	100	X															
2500	Indirect	100	X	X			X											
958218T	Indirect	95	X								X							
603007C	Indirect	50								X								
480	Zero	100		X						X								X
	TOTAL		12	5	3	3	6	5	1	5	11	1	1	1	2	1	1	6

*Based on information reported in 1979 and 1983 questionnaire surveys.

Table VI-6

DISCHARGE MODE FOR PROCESSES IN QUESTIONNAIRE DATA BASE THAT RECYCLE WASTEWATER*

	Discharge Mode							
Type of Wastewater	Direct†	(%)**	Indirect†	(%)	Zero	(%)**	Total	(%)**
Contact Cooling and Heating Water	42	(22)	50	(26)	98	(52)	190	(100)
Cleaning and Finishing Water	2	(13)	7	(47)	6	(40)	15	(100)
TOTAL	44	(21)	57	(28)	104	(51)	205	(100)

*Based on information from 1979 and 1983 questionnaire surveys.

**Percent for type of wastewater.

†Direct and Indirect discharge processes have a continuous or intermittent bleed or discharge from the recycle unit.

(2) 43 plants (10.5 percent) have processes using only cleaning and finishing water, and

(3) 33 plants (8.1 percent) have processes that use contact cooling and heating water and processes that use cleaning and finishing water.

Based on that information, 365 plants (332 + 33) have processes that use contact cooling and heating water and 76 plants (43 + 33) have processes that use cleaning and finishing water.

Estimate of Number of Processes in PM&F Category That Use Process Water

The process and plant information listed above from the questionnaire data base was applied to the estimated 1,898 wet plants in the PM&F category to obtain a preliminary estimate of the number of wet plants and processes in each subcategory. The calculations for the category preliminary plant estimate are:

$$\left(1{,}898\ \begin{array}{c}\text{category}\\ \text{wet}\\ \text{plants}\end{array}\right)(0.814) = \begin{array}{c}\text{1,545 plants with processes}\\ \text{that use only contact}\\ \text{cooling and heating water}\end{array}$$

$$\left(1{,}898\ \begin{array}{c}\text{category}\\ \text{wet}\\ \text{plants}\end{array}\right)(0.105) = \begin{array}{c}\text{199 plants with processes}\\ \text{that use only cleaning and}\\ \text{finishing water}\end{array}$$

$$\left(1{,}898\ \begin{array}{c}\text{category}\\ \text{wet}\\ \text{plants}\end{array}\right)(0.081) = \begin{array}{c}\text{154 plants with processes that}\\ \text{use contact cooling and heating}\\ \text{water and processes that use}\\ \text{cleaning and finishing water}\end{array}$$

This equates to 1,699 plants (1,545 + 154) in the PM&F category with processes that use contact cooling and heating water and 353 plants (199 + 154) with processes that use cleaning and finishing water. The total category process estimate is:

$$\left(1{,}699\ \begin{array}{c}\text{category plants}\\ \text{with processes}\\ \text{that use cooling}\\ \text{and heating water}\end{array}\right)\left(\frac{\begin{array}{c}\text{448 data}\\ \text{base processes}\end{array}}{\begin{array}{c}\text{365 data}\\ \text{base plants}\end{array}}\right) = \begin{array}{c}\text{2,085 processes}\\ \text{that use contact}\\ \text{cooling and}\\ \text{heating water}\end{array}$$

$$\left(353 \begin{array}{c}\text{category plants}\\ \text{with processes}\\ \text{that use cleaning}\\ \text{and finishing water}\end{array}\right)\left(\frac{\begin{array}{c}\text{94 data}\\ \text{base processes}\end{array}}{\begin{array}{c}\text{76 data}\\ \text{base plants}\end{array}}\right) = \begin{array}{c}\text{437 processes}\\ \text{that use cleaning}\\ \text{and finishing}\\ \text{water}\end{array}$$

Applying the percentages for direct, indirect, and zero dischargers from Table VI-1 to the number of wet processes gives an estimate of 667 direct discharge processes, 855 indirect discharge processes, and 563 zero discharge processes for the contact cooling and heating water subcategory and 122 direct discharge processes, 262 indirect discharge processes, and 53 zero discharge processes for the cleaning and finishing water subcategory.

Estimate of Number of Plants in PM&F Category With Processes That Use Process Water

To project the number of direct, indirect, and zero discharge plants in the PM&F category, the number of plants in the data base was distributed by the type of discharge mode (see Table VI-7). A plant can have processes that use more than one type of process water and can have more than one type of discharge mode. For example, a plant can have a process that uses contact cooling and heating water and recycles 100 percent of the process water, making the plant a zero discharger. The same plant can also have a process that uses cleaning and finishing water that is discharged to a publicly owned treatment works (POTW), making the plant an indirect discharger.

For plants with processes that use contact cooling and heating water, the number of plants with direct discharges was calculated by counting the numbers in Table VI-7 in columns one and three for rows one, four, and five. There are 103 plants with contact cooling and heating water processes in the data base that have direct discharges (103 = 90 + 8 + 1 + 1 + 3 + 0 from Table VI-7). This number accounts for the types of process water used and the types of discharge modes.

Similarly, the number of plants in the data base with processes that use cleaning and finishing water with direct discharges was calculated by summing the numbers in columns two and three for rows one, four, and five in Table VI-7. There are 19 plants with processes that use cleaning and finishing water in the data base that have direct discharges (i.e., 10 + 8 + 1 + 0 + 0 = 19). This same technique was used to determine the number of plants in the data base that have indirect discharges and that have zero discharge. The number of direct, indirect, and zero discharge plants in the data base is presented in Table VI-8.

DISTRIBUTION OF PLANTS IN QUESTIONNAIRE DATA BASE BY DISCHARGE MODE

Row	Plant Discharge Mode	Column 1 Plants With Processes That Use Contact Cooling and Heating Water	Column 2 Plants With Processes That Use Cleaning and Finishing Water	Column 3 Plants With Processes That Use Contact Cooling and Heating Water and Processes That Use Cleaning and Finishing Water	Total
1	Direct	90	10	8	108
2	Indirect	134	26	20	180
3	Zero	97	7	2	106
4	Direct & Indirect	1	0	1	2
5	Direct & Zero	3	0	0	3
6	Indirect & Zero	7	0	2	9
		332	43	33	408

Table VI-8

NUMBER OF PLANTS IN DATA BASE

	Contact Cooling and Heating Water Subcategory	(%)	Cleaning and Finishing Water Subcategory	(%)
Number of Plants with Direct Discharge*	103	(27)	19	(24)
Number of Plants with Indirect Discharge**	165	(44)	49	(62)
Number of Plants with Zero Discharge***	111	(29)	11	(14)
TOTAL	379	(100)	79	(100)

*Calculated by summing columns one and three for rows one, four, and five in Table VI-7 for contact cooling and heating water, and columns two and three for rows one, four, and five in Table VI-7 for cleaning and finishing water.

**Calculated by summing columns one and three for rows two, four, and six in Table VI-7 for contact cooling and heating water, and columns two and three for rows two, four, and six in Table VI-7 for cleaning and finishing water.

***Calculated by summing columns one and three for rows three, five, and six in Table VI-7 for contact cooling and heating water, and columns two and three for rows three, five and six in Table VI-7 for cleaning and finishing water.

The 1,699 preliminary plant projection for the contact cooling and heating water subcategory and the 353 preliminary plant projection for the cleaning and finishing water subcategory accounts for plants with processes that use more than one type of process water, but not for plants with more than one type of discharge mode. Those projections were adjusted to account for more than one type of discharge mode by multiplying the preliminary plant projections by the ratio of the number of plants from the questionnaire data base that account for type of process water and type of discharge mode to the number of plants that account only for the type of process water used. The final PM&F category estimate for plants using process water is:

$$\left(1{,}699 \begin{array}{c}\text{PM\&F plants with}\\ \text{processes that use}\\ \text{contact cooling}\\ \text{and heating}\\ \text{water}\end{array}\right)\left(\frac{379}{365}\right) = 1{,}764 \begin{array}{c}\text{PM\&F plants with}\\ \text{processes that use}\\ \text{contact cooling}\\ \text{and heating}\\ \text{water}\end{array}$$

$$\left(353 \begin{array}{c}\text{PM\&F plants with}\\ \text{processes that use}\\ \text{cleaning and}\\ \text{finishing water}\end{array}\right)\left(\frac{79}{76}\right) = 367 \begin{array}{c}\text{PM\&F plants with}\\ \text{processes that use}\\ \text{cleaning and}\\ \text{finishing water}\end{array}$$

These projections account for plants having more than one type of water use and more than one mode of discharge. For this reason, the total number of plants (2,131 = 1,764 + 367) exceeds the estimated 1,898 wet plants presented in Section IV.

The 1,764 plants with contact cooling and heating water processes and the 367 plants with cleaning and finishing water processes were multiplied by the percentages in Table VI-8 to estimate the numbers of direct, indirect, and zero plants in the PM&F category that use process water. These projections are presented in Table VI-9.

Estimate of PM&F Category Process Water Use

For each discharge mode, the estimated number of wet processes for the PM&F category was distributed by flow range based on the percentage of processes from the questionnaire data base in the flow ranges presented in Table VI-2. The annual water use for the PM&F category was calculated by multiplying the average operating hours per year and the average liters of water used per hour listed in Table VI-2 and the estimated number of wet processes in the PM&F category in each flow range.

Table VI-9

PM&F CATEGORY PLANT PROJECTIONS BY DISCHARGE MODE

	Contact Cooling and Heating Water Subcategory	Cleaning and Finishing Water Subcategory
Number of Plants with Direct Discharges	477	88
Number of Plants with Indirect Discharges	778	228
Number of Plants with Zero Discharges	512	51
TOTAL	1,767	367

Table VI-10 presents the distribution of processes in the PM&F category by discharge mode and by type of process water. Approximately 70 percent of the contact cooling and heating water and 65 percent of the cleaning and finishing water is used by processes with a flow rate greater than 300 gpm. However, processes with flow rates greater than 300 gpm are only seven percent of the total number of processes that use contact cooling and heating water and only seven percent of the total number of processes that use cleaning and finishing water.

Estimate of PM&F Category Process Wastewater Discharged

Plants in the plastics molding and forming category discharge approximately 47.3 billion liters per year of wastewater. Table VI-11 contains a distribution of the amount of wastewater discharged by type of process water and discharge mode. These estimates were calculated by multiplying the average operating hours per year listed in Table VI-3, the average liters of wastewater discharged per hour listed in Table VI-3 and the estimated number of wet processes in each flow range. The estimated number of wet processes in the PM&F category was distributed among the flow ranges by multiplying the total number of processes by the percentage of processes in each flow range from the questionnaire data base (see Table VI-3). Approximately 57 percent of the processes that discharge contact cooling and heating water and approximately 73 percent of the processes that discharge cleaning and finishing water have a discharge flow rate of eight gallons per minute or less. However, wastewater discharged by those processes is only approximately five percent of the estimated annual amount of wastewater discharged by contact cooling and heating water processes and only approximately 10 percent of the wastewater discharged by cleaning and finishing processes.

SAMPLING PROGRAMS

The sampling programs for this project were undertaken to identify pollutants in the PM&F wastewater. Samples were collected at plastics molding and forming plants and analyzed for conventional, selected nonconventional, and priority pollutants. This section discusses the sampling programs and presents the results of the sample analyses.

Plant Selection

Criteria used to select PM&F plants for sampling included the number and types of PM&F processes, water use and wastewater discharge practices, and differences in production processes and plastics materials used. The primary source of this information was the questionnaires. The Agency selected plants for sampling believed to represent a full range of PM&F processes and raw materials. Those plants usually had more than one PM&F process.

Table VI-10

ESTIMATED PM&F CATEGORY WATER USE

Contact Cooling and Heating Water Subcategory

Process Water Usage Flow Range (gpm)	Direct Dischargers		Indirect Dischargers		Zero Dischargers	
	Estimated Number of Processes	Estimated Total Water Use (billion l/yr)	Estimated Number of Processes	Estimated Total Water Use (billion l/yr)	Estimated Number of Processes	Estimated Total Water Use (billion l/yr)
$X < 0.3$	33	0.005	89	0.010	47	0.004
$0.3 < X \leq 2$	42	0.045	168	0.136	74	0.084
$2 < X \leq 8$	111	0.590	168	0.716	130	0.749
$8 < X \leq 20$	162	2.79	192	2.98	79	1.31
$20 < X \leq 50$	139	6.03	51	1.41	102	3.47
$50 < X \leq 100$	78	8.29	70	7.02	38	3.61
$100 < X \leq 200$	37	6.95	33	8.83	14	2.34
$200 < X \leq 300$	28	14.3	28	9.49	28	8.30
$300 < X$	37	93.4	56	56.0	51	55.4
TOTAL	667	132.401	855	86.592	563	75.267

Cleaning and Finishing Water Subcategory

Process Water Usage Flow Range (gpm)	Direct Dischargers		Indirect Dischargers		Zero Dischargers	
	Estimated Number of Processes	Estimated Total Water Use (billion l/yr)	Estimated Number of Processes	Estimated Total Water Use (billion l/yr)	Estimated Number of Processes	Estimated Total Water Use (billion l/yr)
$X < 0.3$	14	0.001	60	0.004	9	0.001
$0.3 < X \leq 2$	28	0.032	55	0.078	14	0.017
$2 < X \leq 8$	23	0.133	64	0.205	9	0.070
$8 < X \leq 20$	19	0.301	27	0.273	7	0.006
$20 < X \leq 50$	23	0.870	14	0.191	0	0
$50 < X \leq 100$	5	0.241	14	1.24	0	0
$100 < X \leq 200$	5	1.61	5	0.456	0	0
$200 < X \leq 300$	5	1.50	5	0.558	0	0
$300 < X$	0	0	18	6.16	14	8.35
TOTAL	122	4.688	262	9.165	53	8.444

Table VI-11

ESTIMATED WASTEWATER DISCHARGE - PM&F CATEGORY

Contact Cooling and Heating Water Subcategory

Discharge Flow Range (gpm)	Direct Dischargers		Indirect Dischargers	
	Estimated Number of Processes	Estimated Wastewater Discharge (billion l/yr)	Estimated Number of Processes	Estimated Wastewater Discharge (billion l/yr)
$X < 0.3$	79	0.007	159	0.016
$0.3 < X \leq 2$	83	0.145	210	0.211
$2 < X \leq 8$	148	0.932	192	0.867
$8 < X \leq 20$	148	2.73	173	2.75
$20 < X \leq 50$	116	4.83	66	2.36
$50 < X \leq 100$	51	6.14	32	3.32
$100 < X \leq 200$	28	4.01	9	1.56
$200 < X \leq 300$	5	2.18	14	5.15
$300 < X$	9	5.26	0	0
TOTAL	667	26.234	855	16.234

Cleaning and Finishing Water Subcategory

Discharge Flow Range (gpm)	Direct Dischargers		Indirect Dischargers	
	Estimated Number of Processes	Estimated Wastewater Discharge (billion l/yr)	Estimated Number of Processes	Estimated Wastewater Discharge (billion l/yr)
$X < 0.3$	14	0.001	78	0.007
$0.3 < X \leq 2$	28	0.032	69	0.092
$2 < X \leq 8$	28	0.146	64	0.177
$8 < X \leq 20$	19	0.301	28	0.280
$20 < X \leq 50$	23	0.832	14	0.191
$50 < X \leq 100$	5	0.241	9	0.917
$100 < X \leq 200$	5	1.61	0	0
$200 < X \leq 300$	0	0	0	0
$300 < X$	0	0	0	0
TOTAL	122	3.163	262	1.664

Field Sampling

After selection of candidate plants, each plant was contacted by telephone to verify their operations and to inform them that EPA had included them in the sampling program. Presampling site visits were conducted to identify sample locations, sampling conditions, and plant operations.

Eleven plants were sampled during this project. Plants C, E, F, and I were sampled in 1980 and the remaining seven plants, A, B, D, G, H, J, and K, were sampled in 1983. Figures VI-1 through VI-11 present wastewater flow diagrams for the 11 plants indicating the location of the sample points. Eighteen contact cooling and heating water processes were sampled at nine PM&F plants. Five different types of contact cooling and heating water processes were sampled at those plants. Thirteen cleaning and finishing water processes were sampled at seven PM&F plants. Twelve of those processes were cleaning processes and one was a finishing process. Table VI-12 lists the processes sampled in each subcategory and the process water usage flow rate for each process.

Sample Collection, Preservation, and Transportation

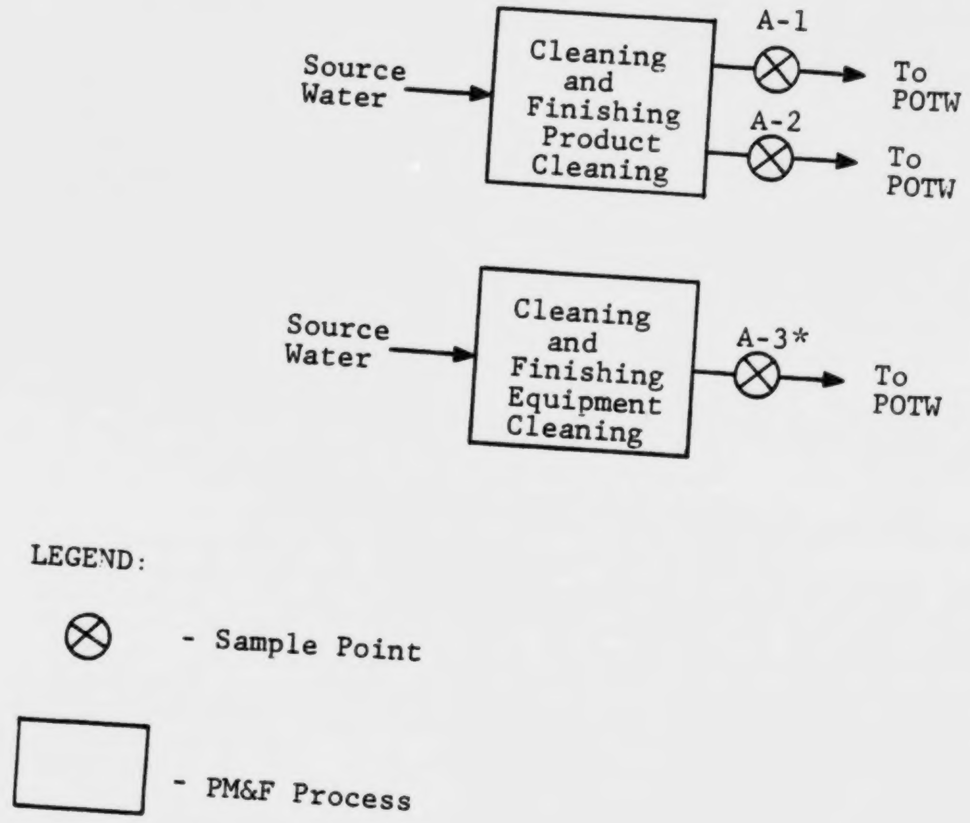
Collection, preservation, and transportation of samples were performed in accordance with procedures outlined in Appendix III of "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants" (published by the Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, March 1977, revised, April 1977) and in "Sampling Screening Procedure for the Measurement of Priority Pollutants" (published by the EPA Effluent Guidelines Division, Washington, D.C., October 1976). The procedures for collection, preservation, and transportation of samples to be tested for conventional and nonconventional pollutants were performed as described in the test methods (see Table VI-14).

Sample Analysis

Once collected in the field, samples were prepared and shipped via overnight air express to EPA contract laboratories for analysis. Pollutants for which analyses were conducted are presented in Table VI-13. The analytical methods used are listed in Table VI-14. The analytical detection limits for the priority pollutants are listed in Table VI-15.

Field Quality Assurance/Quality Control (QA/QC)

Field QA/QC procedures for the sampling program included taking duplicate, blank, preserved blank, and source water samples.



*Data from this point were not used in data analyses because production data were not available for this process.

Figure VI-1

SAMPLING POINTS AT PLANT A

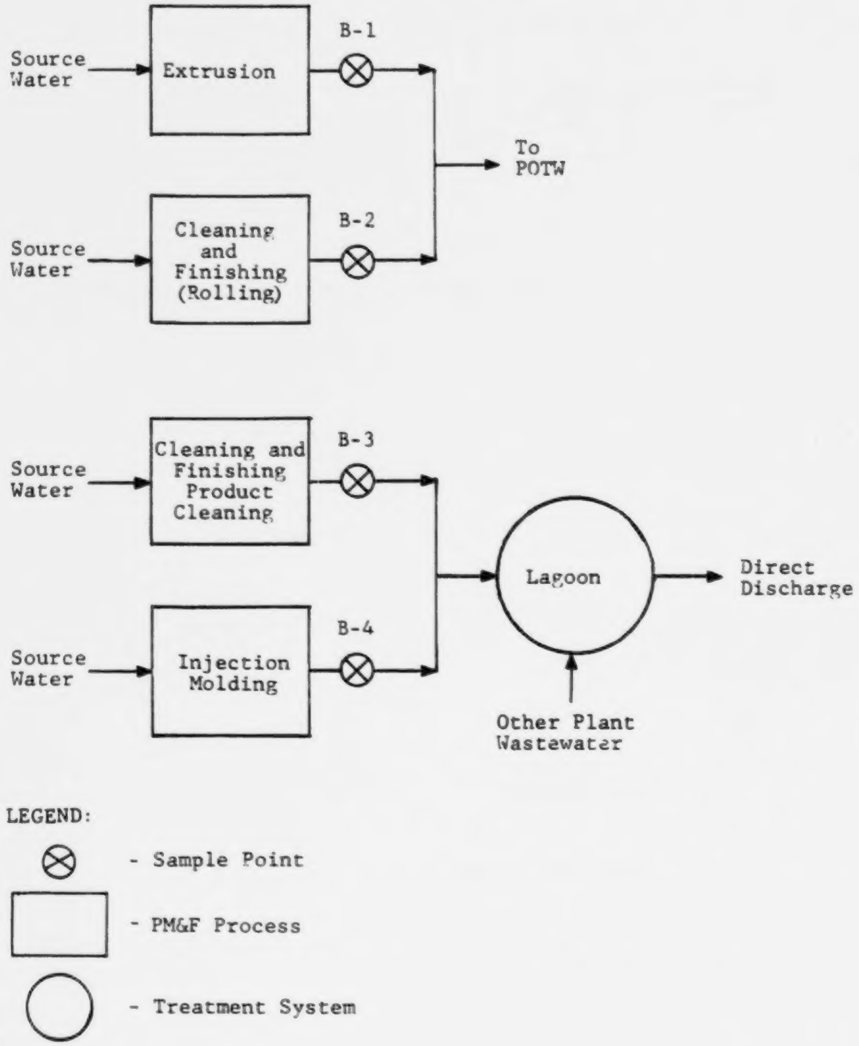
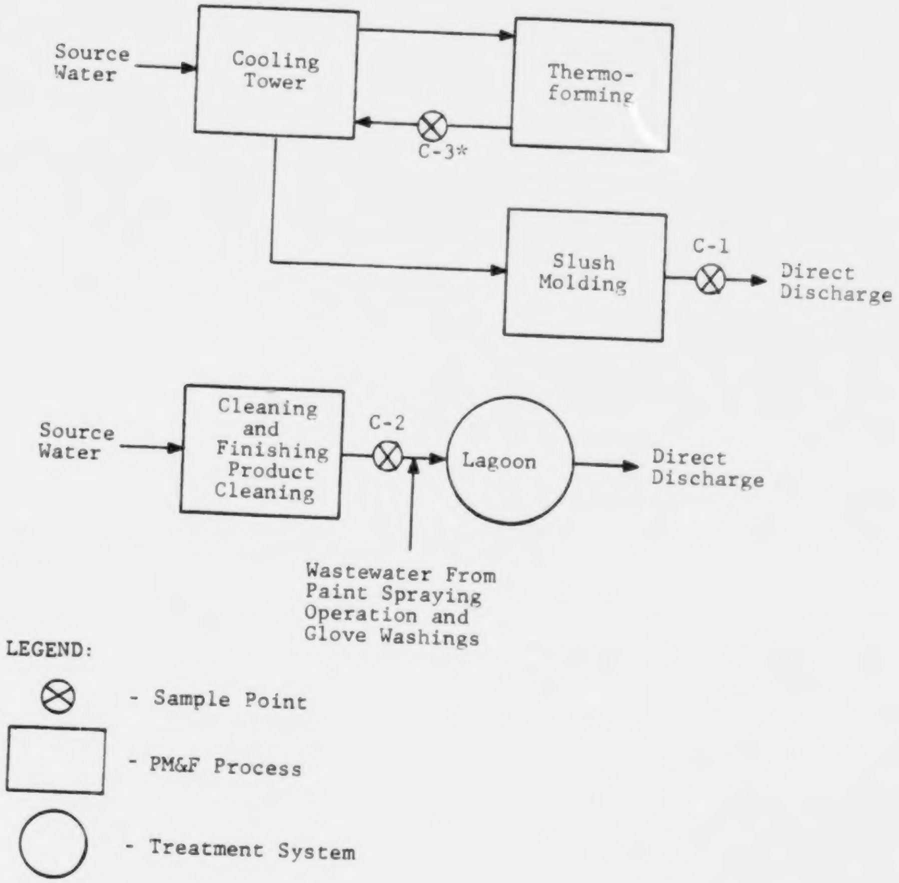


Figure VI-2

SAMPLING POINTS AT PLANT B



*Data from this point were not used in data analyses because process is no longer in operation.

Figure VI-3

SAMPLING POINTS AT PLANT C

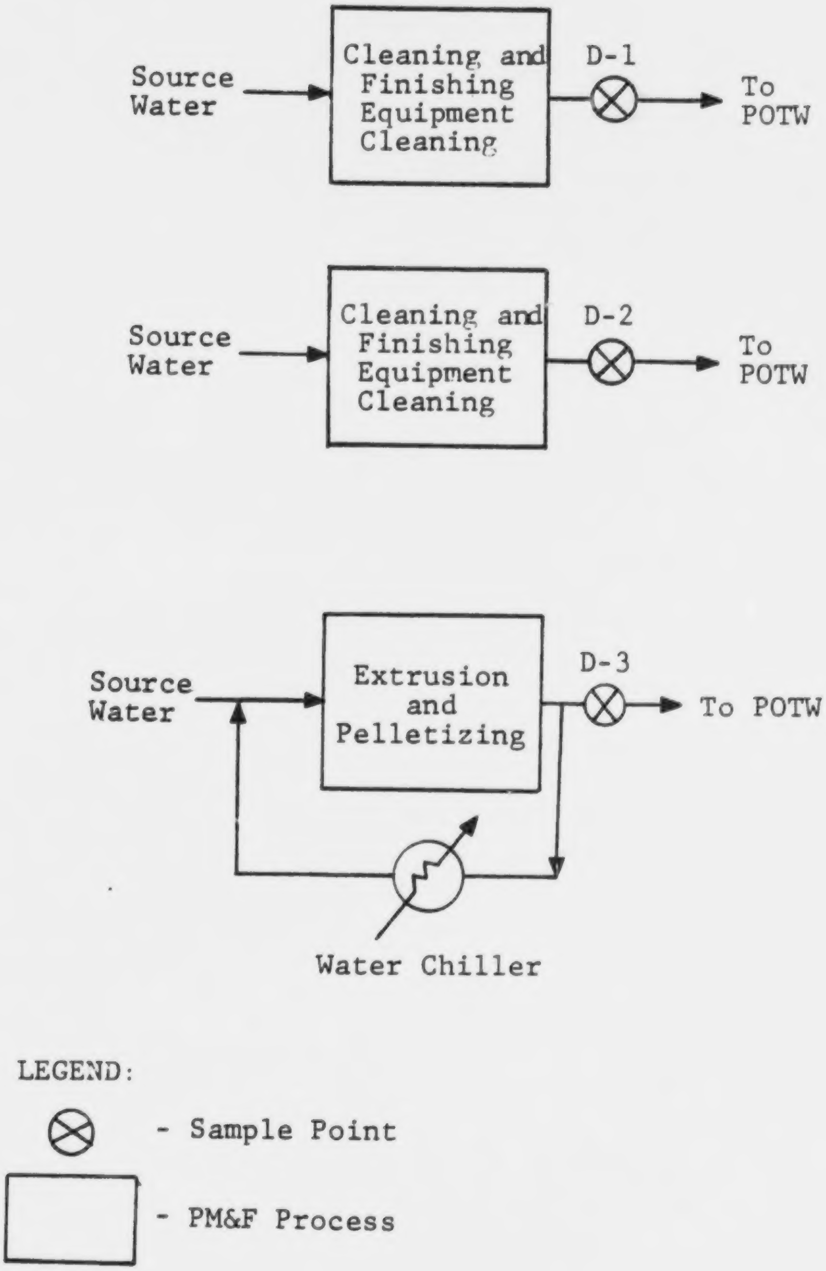


Figure VI-4

SAMPLING POINTS AT PLANT D

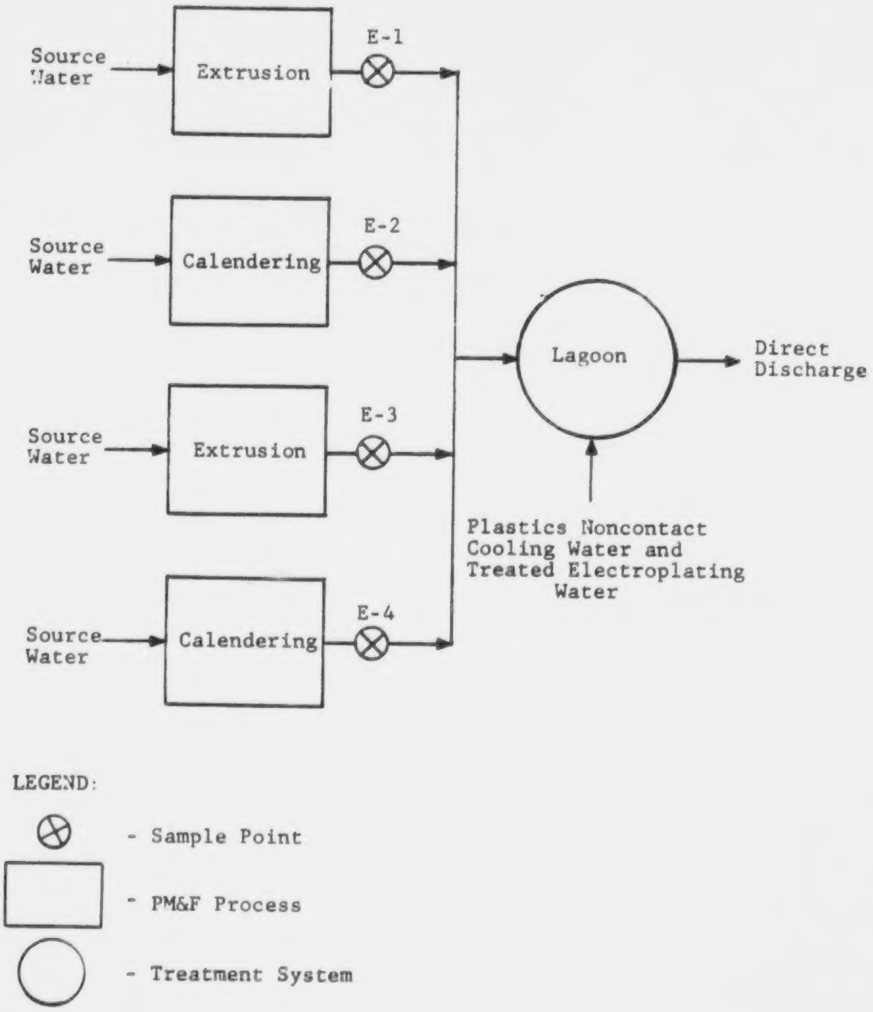


Figure VI-5

SAMPLING POINTS AT PLANT E

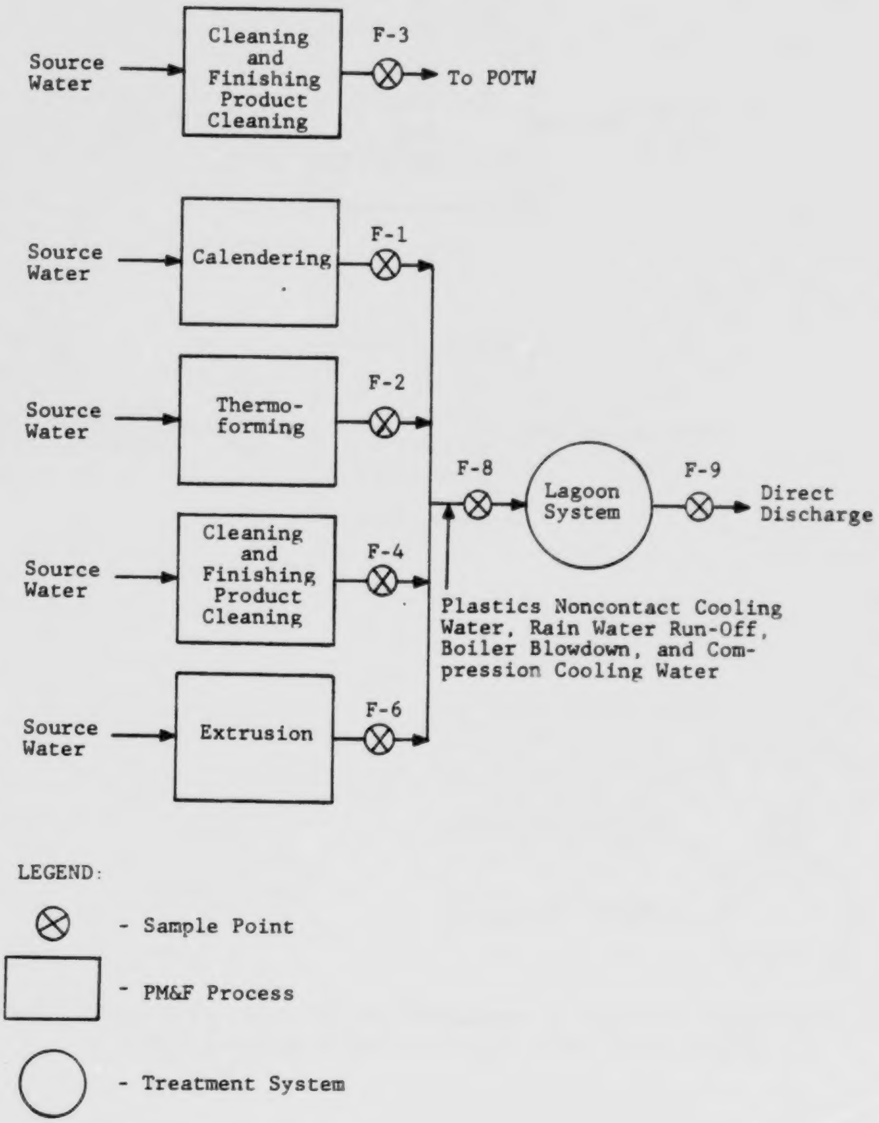
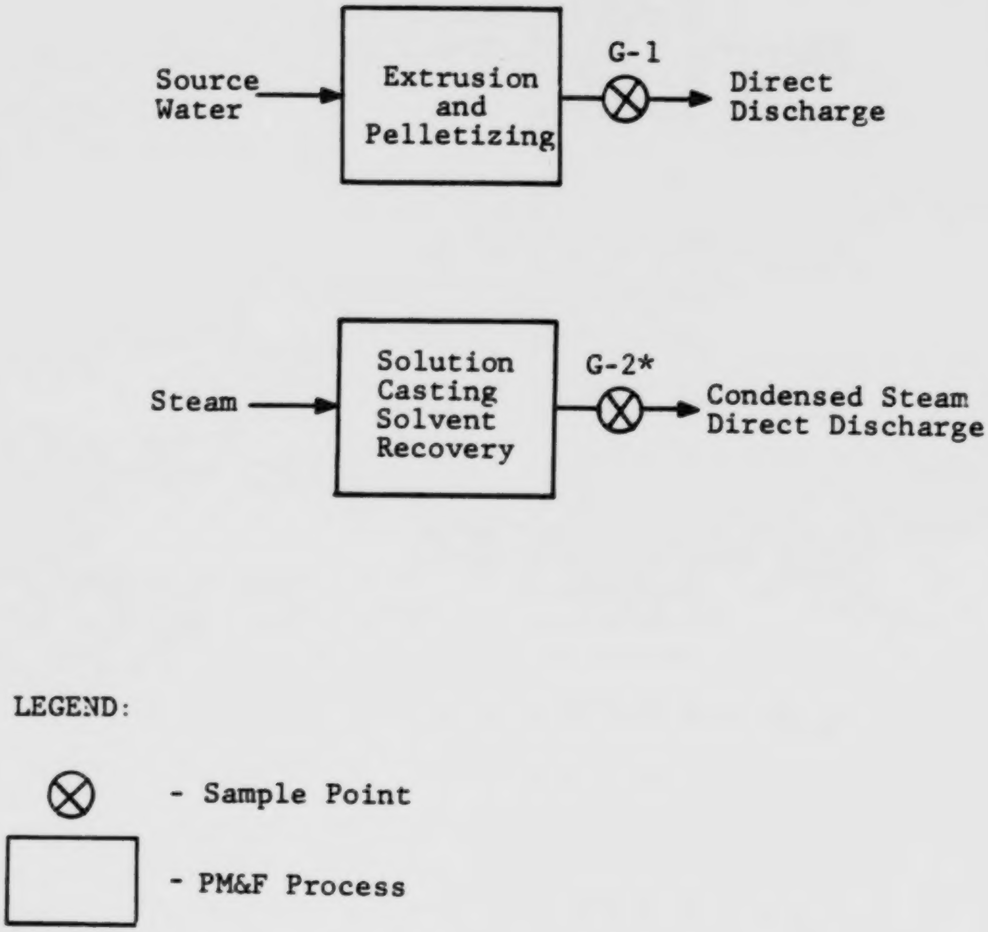


Figure VI-6

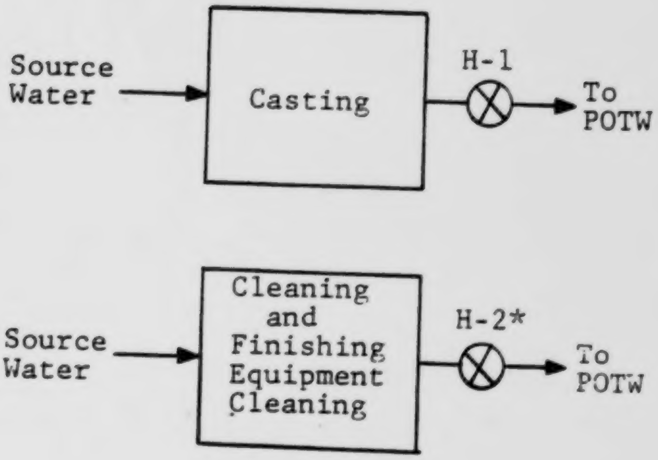
SAMPLING POINTS AT PLANT F


Source Water
Extrusion and Pelletizing
G-1
Direct Discharge
Steam
Solution Casting Solvent Recovery
G-2*
Condensed Steam Direct Discharge
LEGEND:
- Sample Point
- PM&F Process

*Solvent recovery wastewater is not regulated by the proposed effluent limitations guidelines.

Figure VI-7

SAMPLING POINTS AT PLANT G



LEGEND:

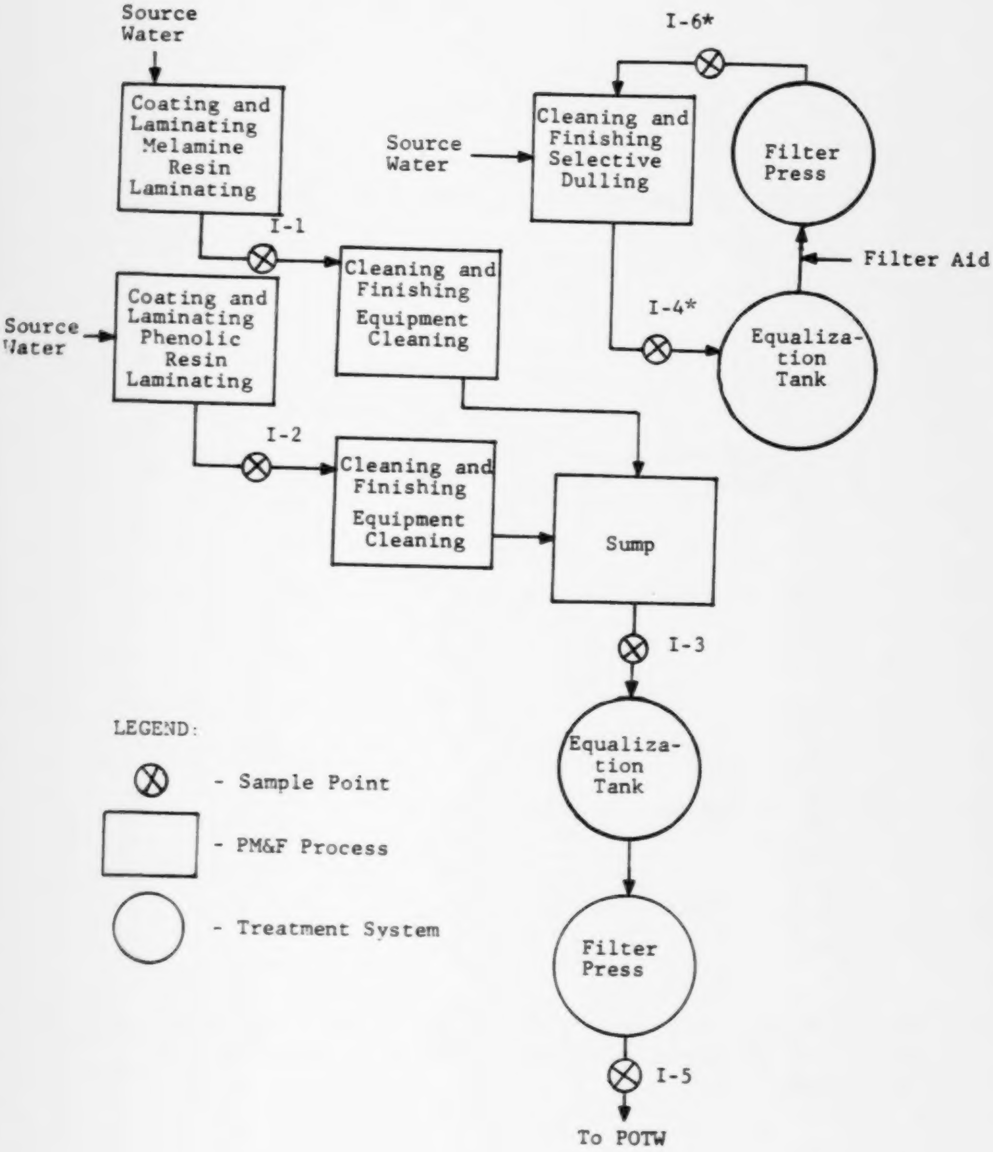
⊗ - Sample Point

☐ - PM&F Process

*Data from this point were not used in data analyses because production data were not available for this process.

Figure VI-8

SAMPLING POINTS AT PLANT H


Source Water
Coating and Laminating Melamine Resin Laminating
I-1
Coating and Laminating Phenolic Resin Laminating
Source Water
Cleaning and Finishing Equipment Cleaning
I-2
Cleaning and Finishing Equipment Cleaning
I-6*
Source Water
Cleaning and Finishing Selective Dulling
Filter Press
Filter Aid
I-4*
Equalization Tank
Sump
I-3
Equalization Tank
Filter Press
I-5
To POTW
LEGEND:
- Sample Point
- PM&F Process
- Treatment System

*Data from this point were not used in data analyses because production data were not available for this process.

Figure VI-9

SAMPLING POINTS AT PLANT I

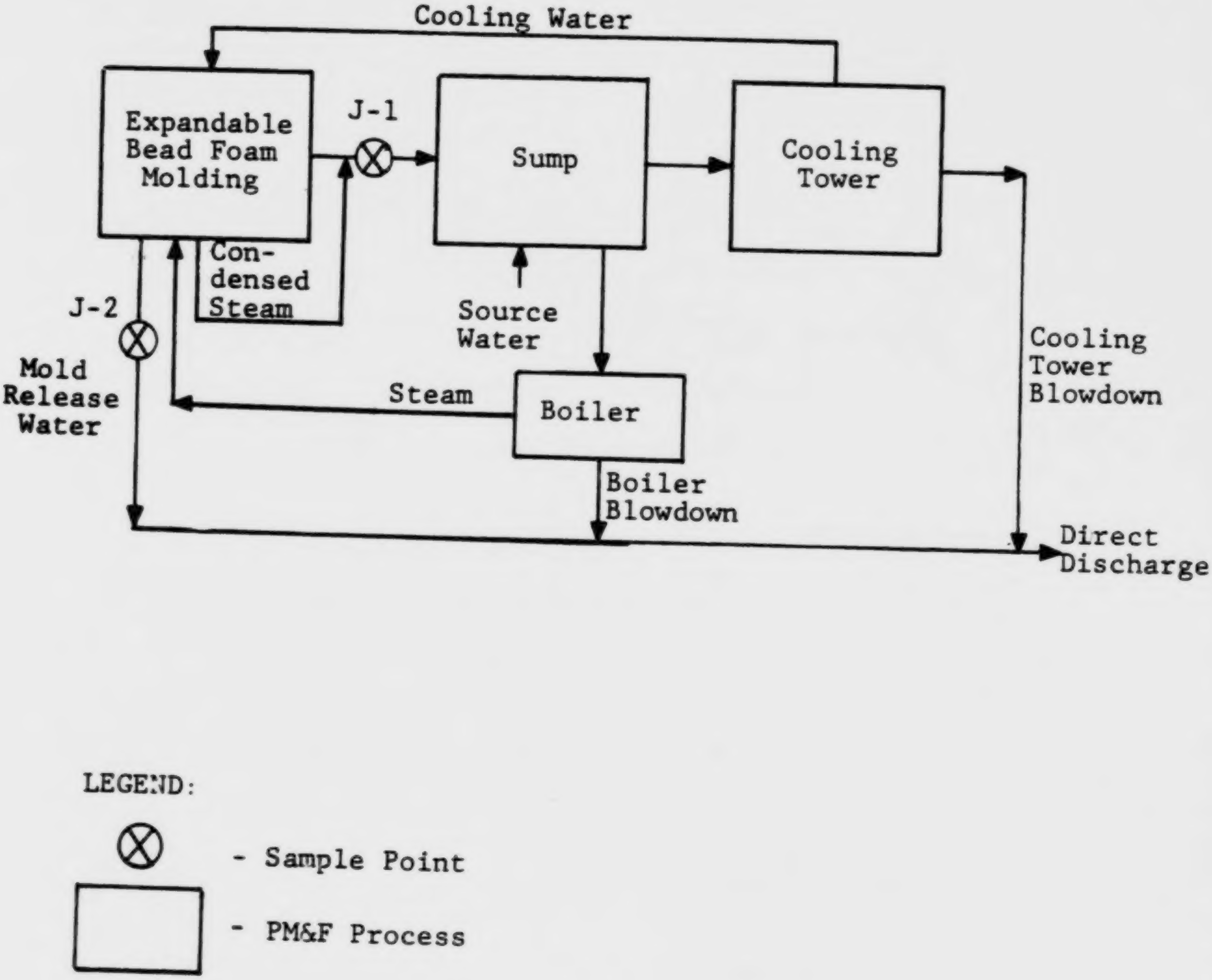


Figure VI-10

SAMPLING POINTS AT PLANT J

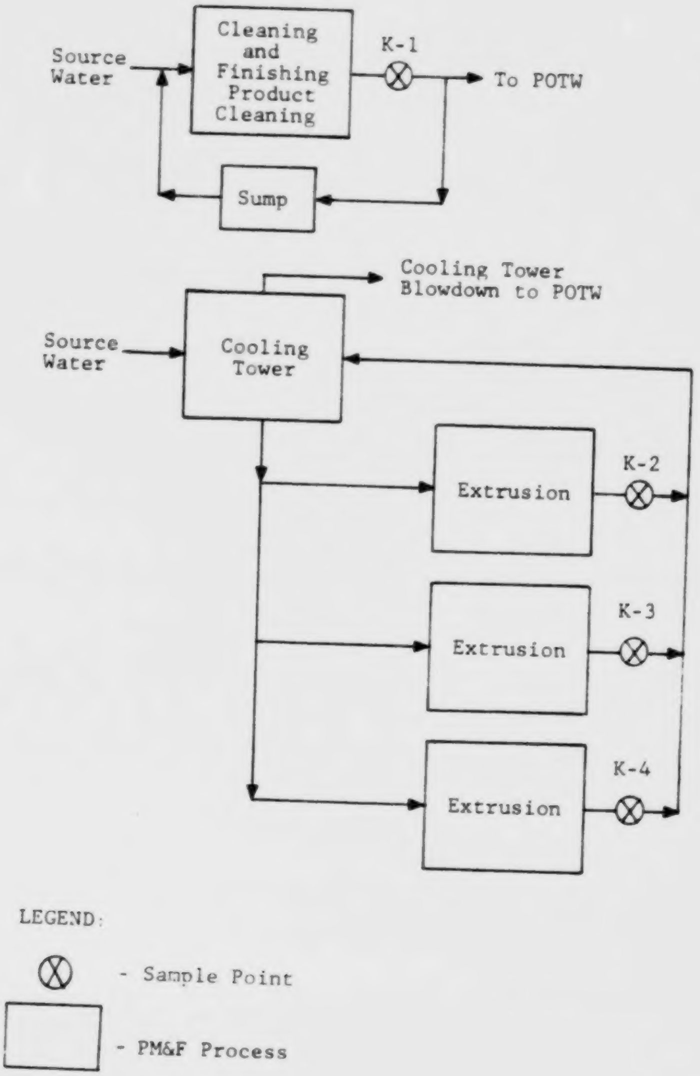


Figure VI-11

SAMPLING POINTS AT PLANT K

Table VI-12

SAMPLED PROCESSES

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Process Code	Type of Process	Process Water Usage Flow Rate (gpm)
B-1	extrusion	0.8
B-4	injection molding	0.025
C-1	slush molding	0.28
D-3	pelletizing (extrusion)	50 gal/batch
E-1	wire coating (extrusion)	5
E-2	calendering	14
E-3	wire coating (extrusion)	35
E-4	calendering	40
F-1	calendering	2.3
F-2	vacuum forming	1.8
F-6	extrusion	2
G-1	pelletizing (extrusion)	1.45
H-1	dip casting	0.07
J-1	foam injection molding	120
J-2	molding	9
K-2	extrusion	4
K-3	extrusion	2
K-4	extrusion	167

CLEANING AND FINISHING WATER SUBCATEGORY

Process Code	Type of Process	Process Water Usage Flow Rate (gpm)
A-1	parts washing	10 gal/batch
A-2	oxalic acid parts washing	40 gal/batch
B-2	rolling (finishing operation)	1.8
B-3	lens cleaning	20
C-2	parts washing	2.0
D-1	tank cleaning	15 gal/batch
D-2	tank cleaning	15 gal/batch
F-3	parts washing and rinsing	3.4
F-4	parts washing and rinsing	7.4
I-1	resin application equipment cleanup	1.4
I-2	resin application equipment cleanup	0.7
I-3	resin application equipment cleanup	1.6
K-1	parts washing	0.5

Table VI-13

POLLUTANTS FOR WHICH SAMPLES WERE ANALYZED

PRIORITY POLLUTANTS

Base/Neutral Compounds

Acenaphthene
Benzidine
1,2,4-Trichlorobenzene
Hexachlorobenzene
Hexachloroethane
bis (2-Chloroethyl) ether
1,2-Dichlorobenzene
2-Chloronaphthalene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
2,4-Dinitrotoluene
2,6-Dinitrotoluene
1,2-Diphenylhydrazine
 (as azobenzene)
Fluoranthene
4-Chlorophenyl phenyl ether
4-Bromophenyl phenyl ether
bis (2-Chloroisopropyl) ether
bis (2-Chloroethoxy) methane
Hexachlorobutadiene
Hexachlorocyclopentadiene
Isophorone

Naphthalene
Nitrobenzene
N-Nitrosodimethylamine
N-Nitrosodiphenylamine
N-Nitrosodi-n-propylamine
bis (2-Ethylhexyl) phthalate
Butyl benzyl phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate
Diethyl phthalate
Dimethyl phthalate
Benzo(a)anthracene
Benzo(a) pyrene
3,4-Benzofluoranthene
Benzo(k)fluoranthene
Chrysene
Acenaphthylene
Anthracene
Benzo (g,h,i)perylene
Fluorene
Phenanthrene
Dibenzo(a,h)anthracene
Indeno(1,2,3-c,d)pyrene
Pyrene
2,3,7,8-Tetrachlorodibenzo-p-dioxin

PRIORITY POLLUTANTS

Pesticides

Aldrin
Dieldrin
Chlordane
4,4'-DDT
4,4'-DDE
4,4'-DDD
α-Endosulfan
β-Endosulfan
Endosulfan sulfate
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
α-BHC
β-BHC
γ-BHC
δ-BHC
PCB-1242
PCB-1254
PCB-1221
PCB-1232
PCB-1248
PCB-1260
PCB-1016
Toxaphene

Volatiles

Acrolein
Acrylonitrile
Benzene
Carbon tetrachloride
Chlorobenzene
1,2-Dichloroethane
1,1,1-Trichloroethane
1,1-Dichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
Chloroethane
bis (Chloromethyl) ether[1]
2-Chloroethylvinyl ether
Chloroform
1,1-Dichloroethylene
1,2-trans-Dichloroethylene
1,2-Dichloropropane
1,2-Dichloropropylene
Ethylbenzene
Methylene chloride
Methyl chloride
Methyl bromide
Bromoform
Dichlorobromomethane
Trichlorofluoromethane[1]
Dichlorodifluoromethane[1]
Chlorodibromomethane
Tetrachloroethylene
Toluene
Trichloroethylene
Vinyl chloride

PRIORITY POLLUTANTS

Acid Compounds

2,4,6-Trichlorophenol
p-Chloro-m-cresol
2-Chlorophenol
1,4-Dichlorophenol
2,4-Dimethylphenol
2-Nitrophenol
4-Nitrophenol
2,4-Dinitrophenol
4,5-Dinitro-o-cresol
Pentachlorophenol
Phenol

Other

Cyanide
Asbestos

Metals

Antimony
Arsenic
Beryllium
Chromium
Cadmium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

NONCONVENTIONAL WASTEWATER POLLUTANTS

Chemical Oxygen Demand (COD)
Ammonia
Total Kjeldahl Nitrogen
Total Phosphorus
Total Organic Carbon (TOC)
Total Phenolics (4AAP)
Sulfate
Sulfite
Sulfide
Nitrates
Fluoride
Free Chlorine
Boron
Bromide
Surfactants

NONCONVENTIONAL METAL POLLUTANTS

Calcium
Magnesium
Aluminum
Manganese
Vanadium
Boron
Barium
Molybdenum
Tin
Yttrium
Cobalt
Iron
Titanium

CONVENTIONAL POLLUTANTS

Biochemical Oxygen Demand (BOD)
pH
Oil and Grease
Total Suspended Solids (TSS)

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[1] These compounds have been recently removed from the priority pollutant list (see 46 FR 2266, January 8, 1981, and 46 FR 10723, February 4, 1981).

Table VI-14

ANALYTICAL METHODS SUMMARY

Conventional and Nonconventional Pollutants	USEPA Methods†	Standard Methods††
BOD_5	405.1	
COD	410.1, 410.2	
TOC	415.1	
TSS	160.2	
Bromide		405
Fluoride	340.1	
Ammonia	350.1	
Total Kjeldahl Nitrogen (TKN)	351.3	
Nitrate-Nitrite Nitrogen (as N)	353.2	
Oil and Grease		503C
Phosphorus (total)	365.1	
Boron		404B
Sulfate (as SO4=)	375.2	
Sulfide (as S)	376.2	
Surfactants (MBAS)	425.1	512A
pH	150.1	
Cyanide (total)	335.3	
Phenols (total)	420.2	
Metals	Inductively Coupled Plasma (ICP) Opticals - Emission Spectrometer Method (Task 1)†††	
Calcium		
Magnesium		
Sodium		
Aluminum		
Manganese		
Vanadium		
Boron		
Barium		
Molybdenum		
Tin		
Yttrium		
Cobalt		
Iron		
Titanium		

†USEPA Methods for Chemical Analysis of Water and Wastes, USEPA, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, March 1979, EPA-600/4-79-020.

††Standard Methods for the Examination of Water and Wastewater, 15 Edition, 1981.

†††Procedures are described in "Guidelines Establishing Test Procedures for Analysis of Pollutants; Proposed Regulations, Appendix IV," Federal Register, December 3, 1979, p. 69559.

Table VI-14 (Continued)

ANALYTICAL METHODS SUMMARY

Priority Toxic Pollutants	USEPA Method†
Acid Extraction	1625*
Base/Neutral Extraction	1625*
Volatile Organics	1624*
Pesticides and PCB's	608
Metals Lead Beryllium Cadmium Chromium Copper Nickel Zinc	Inductively Coupled Plasma (ICP) Optical - Emission Spectrometer Method (Task 1)††
Metals Selenium Thallium Silver Arsenic Antimony Mercury	Flameless Atomic Absorption Spectrometer Method (Task 2)†
Metals Lead Beryllium Cadmium Chromium Copper Nickel Zinc	Flame Atomic Absorption Spectrometer Method (Task 2)†

*In cases where isotopes were not available USEPA Methods 624 and 625 were used.

†USEPA Methods for Chemical Analysis of Water and Wastes, USEPA, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, March 1979, EPA-600/4-79-020.

††Procedures are described in "Guidelines Establishing Test Procedures for Analysis of Pollutants; Proposed Regulations, Appendix IV," Federal Register, December 3, 1979, p. 69559.

Table VI-15

DETECTION LIMITS FOR PRIORITY POLLUTANTS

Pollutant	Analytical* Detection Limit (ug/l)
Base/Neutral Extractable Compounds	
N-nitrosodimethylamine	250
isophorone	50
hexachlorocyclopentadiene	250
benzidine	50
3,3'-dichlorobenzidene	50
indeno(1,2,3-cd)pyrene	25
dibenzo(ah)anthracene	25
benzo(ghi)perylene	25
all other base/neutral compounds	10
Acid Extractable Compounds	
2,4-dimethylphenol	250
2,4-dinitrophenol	250
2-methyl-4,6-dinitrophenol	250
pentachlorophenol	125
all other acid compounds	25
Volatile Compounds	
acrolein	100
acrylonitrile	100
all other volatile compounds	10
Pesticides	
aldrin	0.003
dieldrin	0.006
chlordane	0.04
4,4'-DDT	0.016
4,4'-DDE	0.006
4,4'-DDD	0.012
α-endosulfan	0.005
β-endosulfan	0.010
endosulfan sulfate	0.03
endrin	0.009
endrin aldehyde	0.023
heptachlor	0.002
heptachlor epoxide	0.004

Table VI-15 (Continued)

DETECTION LIMITS FOR PRIORITY POLLUTANTS

Pollutant	Analytical* Detection Limit (ug/l)
Pesticides (Continued)	
α-BHC	0.002
β-BHC	0.004
γ-BHC	0.004
δ-BHC	0.002
PCB-1242	0.05
PCB-1254	0.06
PCB-1221	0.10
PCB-1232	0.10
PCB-1248	0.06
PCB-1260	0.15
PCB-1016	0.04
toxaphene	0.40
Metals	
antimony	100
arsenic	53
beryllium	0.3
cadmium	4
chromium	7
copper	6
lead	42
mercury	0.1
nickel	15
selenium	75
silver	7
thallium	100
zinc	2
Others	
cyanide	20

*These analytical detection limits are from the USEPA test method for the organic acid, base neutral, and volatile pollutants. The limits for the pesticides and metals are from the Federal Register, Monday, December 3, 1979, "Guidelines Establishing Test Procedures for the Analysis of Pollutants; Proposed Regulations."

Field Duplicates. Duplicate samples were collected at one sampling point at each of the sampled plants. The identity of the duplicate samples was not made known to the laboratories. Oil and grease and organic volatile (VOA) samples were collected in duplicate and shipped to the laboratory.

Field Blanks. As required by sampling protocol, organic-free water was flushed through each automatic sampler prior to the start of sampling at each plant. One gallon of that water was collected and shipped to the contract laboratory. This sample was the non-volatile organic pollutant blank sample.

Duplicate volatile organics (VOA) blanks were supplied in 40 milliliter vials at each sampling point by the laboratory. Both preserved and unpreserved VOA blanks were supplied by the laboratory The VOA blanks were prepared in the laboratory, transported to the sampling site, placed at selected locations at the sampling site, and then returned to the laboratory after conclusion of the sampling period.

Preservative/Container Blanks. To verify that there was no contamination from the various chemicals used as preservatives or from the sample containers, organic free water supplied by the laboratory was poured into the appropriate sample containers. These samples were preserved and shipped to appropriate laboratories for analysis.

Fresh Water Samples. To assess potential presence of conventional, nonconventional, and toxic pollutant parameters in the source water for each plant, samples of the source water were collected, preserved, shipped to the laboratory, and analyzed for the pollutants listed in Table VI-13.

Bottle/Glassware Preparation. Sample containers and glassware that come in contact with the wastewater samples were prepared according to the procedures outlined in Table VI-16. With the exceptions of grease and oil jars, field blank and preservative blank containers, and the nonvolatile (NVO) composite jug, sample containers were rinsed with wastewater prior to use.

Composite Samples. Composite samples were collected using an ISCO Model 1580 Sampler equipped with new silastic pump tubing and new teflon sample lines. An aluminum rod was used to anchor the sample line in place if necessary. The equipment was programmed to collect a minimum of nine quarts (8,516 milliliters) of wastewater over the duration of each sampling day. The minimum aliquot size was 100 milliliters and the maximum interval between aliquot collection was 30 minutes.

Table VI-16

CONTAINER AND GLASSWARE PREPARATION PROCEDURES

Container	Type	Size	Preparation
Composite Jug	Glass	2.5-5 gallons	Scrub with hot detergent water, rinse with tap water, rinse with blank water, rinse with methylene chloride. Use Teflon liners in caps.
NVO Jug	Glass	1 gallon	
Blank Water Jug	Glass	1 gallon	
Graduated Cylinders	Glass	250/2000 ml	
VOA Vial, Septa, Screw Cap	Glass	40 ml	New containers were used each time after being cleaned according to procedures outlined above.
Phenol	Amber Glass	8 ounce	New containers, caps and Teflon liners washed with hot water, rinsed with tap water and blank water.
Cyanide	Plastic	1 quart	New containers and caps washed with hot water and rinsed with tap water and blank water.
Metals	Plastic Pipets	1 quart	New containers washed with detergent water, rinsed with tap water, rinsed with deionized water, rinsed with 1:1 ultra-pure nitric acid.
Conventional/Nonconventional Parameters	Plastic	0.5 gallon	New containers.
Acidified Conventional/Nonconventional	Plastic	quart	New containers.
Sulfide	Plastic	pint	New containers.
Sulfite	Plastic	8 ounce	New containers.
Free Chlorine	Plastic	8 ounce	New containers.
Grease and Oil	Glass Widemouth	quart	New containers washed with soap and water, rinsed with tap water, rinsed with D.I. water, rinsed with acetone, rinsed with freon.

The operation of each sampler was checked periodically throughout the sampling day. Batteries used with the samplers were changed on a daily basis to avoid problems.

At the conclusion of collection of each composite sample period, contents of the jug were thoroughly mixed by shaking before being transferring to individual containers. Graduate cylinders were used to transfer the sample from the sample jug to the container to avoid spillage.

Free Chlorine Determination. A free chlorine determination was made with potassium iodide paper at each sampling point at the beginning of each sampling day. The appropriate samples were preserved if free chlorine was present in excess of one ppm.

Sample Preservation. All samples were maintained at 4°C during the sampling period. All preservatives were purchased fresh and placed in new containers. Cyanide and phenol samples were collected via grab samples and preserved with appropriate chemicals as soon as they were collected. Grease and oil samples were single grab samples preserved with sulfuric acid. VOA samples were individual grab samples collected four times per day and preserved with sodium metabisulfate, if necessary. Individual pipets were used for each preservative and discarded after use to avoid cross-contamination.

pH Measurement. pH was monitored at each sampling location using pH meters. The meter was buffered before use with pH 4, 7, and 10 buffering agents.

Temperature Measurement. Temperature was measured with metal dial thermometers. Mercury thermometers were not used because of potential contamination of the wastewater in case the thermometer broke.

Laboratory Quality Assurance/Quality Control (QA/QC)

Quality control measures used in the laboratory are presented in "Handbook for Analytical Quality Control in Water and Wastewater Laboratories" (published by EPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, 1976). As part of the analytical quality control program, duplicates and blanks (including sealed VOA samples of blank water carried to each sampling site and returned unopened and samples of preserved and unpreserved equipment blank water) were analyzed. Standards and spiked samples were also analyzed. As part of the analytical QA/QC, all instruments (such as balances, spectrophotometers, and recorders) were routinely maintained and calibrated.

WASTEWATER POLLUTANT CHARACTERISTICS

Analytical data for each type of process wastewater were summarized and are presented in this section. The tables that present the data contain the following information for each analyzed pollutant:

1. number of samples analyzed;
2. number of times a pollutant was detected;
3. number of times a pollutant was detected above the source water (i.e., plant intake water) and above the test method analytical detection limit;
4. subcategory concentration range; and
5. subcategory average concentration.

Table VI-17 presents this summarized data for both subcategories. The daily data used to calculate the summaries in Table VI-17 are presented in Appendix A. Table VI-18 presents the data editing rules and the concentration averaging technique methodology used to calculate the concentration values reported in Table VI-17.

As shown in Table VI-18, priority pollutant data were first eliminated for a process because the pollutant was never detected or detected at or below the analytical detection limit. Data were next eliminated if the source water concentrations were equal to or greater than the effluent concentrations. After these data editing steps, the remaining pollutant data for days one, two, three, and the duplicate of a process were averaged. For each pollutant, the process averages were averaged to calculate an overall subcategory average concentration. The concentration range for the processes within a subcategory was determined by finding the smallest and largest concentration values remaining after the data elimination procedure. The subcategory average concentrations and the ranges for the tested pollutants are presented in Table VI-17.

Priority organic pollutant analytical results were frequently reported from the laboratory as less than values. Values that were less than 0.01 milligrams per liter for acids, base neutrals and volatile organic priority polltuants were listed as asterisks in Appendix A. These values were not used to obtain the average concentration because 0.01 milligrams per liter is the analytical detection limit for those pollutants. Values of less than 0.005 milligrams per liter for pesticide priority pollutants were listed as double asterisks in Appendix A. The double asterisks values for the pesticides were averaged as zeroes because those

Table VI-17

SUMMARY OF SAMPLE DATA

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Conventional Pollutants	Number of Samples	Number of Times Detected	Number of Times* Detected Above Source and Method Detection Limit	Concentration Range** (mg/l)	Average Concentration** (mg/l)
biological oxygen demand (BOD)	42	42	23	3-1,000	102
oil and grease	46	46	19	4-73	21
pH	43	NA	NA	(5.4-8.3)	NA
total suspended solids (TSS)	46	46	22	2-104	17
Nonconventional Pollutants					
aluminum	36	25	11	0.041-0.800	0.359
ammonia nitrogen	46	46	6	0.09-8.4	2.1
barium	41	28	18	0.02-0.19	0.076
boron	41	20	10	0.01-0.17	0.074
bromide	23	23	1	0.8	0.8
calcium	41	40	17	2.9-406	72
chemical oxygen demand (COD)	46	46	27	5-2,280	241
cobalt	41	16	16	0.028-0.142	0.081
cyanide (amenable)	25	25	1	<0.010	<0.010
fluoride	23	23	2	0.4-1.25	0.825
iron	41	37	29	0.038-9.850	0.712
Kjeldahl nitrogen	46	43	11	0.1-1.15	0.496
magnesium	41	41	29	0.900-29.8	12.1
manganese	41	20	19	0.029-0.210	0.060
molybdenum	41	6	6	0.021-0.15	0.061
nitrate	23	23	5	0.2-6.6	2.87
phenols (total)	46	46	13	0.023-1,670	149
sodium	41	40	15	2.1-207	51.7
sulfate	23	23	0	NA	NA
sulfide	21	21	0	NA	NA
surfactants	44	44	17	0.02-28.86	2.984
tin	41	16	7	0.012-0.12	0.051
titanium	41	21	13	0.004-0.290	0.038
total dissolved solids (TDS)	23	23	15	60-150	89.1
total organic carbon (TOC)	46	46	38	2-800	74
total phosphorus	46	46	20	0.04-3.25	0.718
vanadium	42	9	9	0.002-0.056	0.014
yttrium	42	4	4	0.005-0.019	0.008

Table VI-17 (Continued)

SUMMARY OF SAMPLE DATA

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutants	Number of Samples	Number of Times Detected	Number of Times* Detected Above Source and Method Detection Limit	Concentration Range** (mg/l)	Average Concentration** (mg/l)
1. acenaphthene	44	4	0	NA	NA
4. benzene	47	22	3	0.019-0.045	0.029
5. benzidene	44	2	0	NA	NA
6. carbon tetrachloride (tetrachloromethane)	46	13	4	0.026-2.4	1.176
7. chlorobenzene	41	6	0	NA	NA
10. 1,2-dichloroethane	45	1	0	NA	NA
11. 1,1,1-trichloroethane	47	26	7	0.011-0.093	0.037
12. hexachloroethane	43	2	2	0.018-0.021	0.020
22. parachlorometa cresol	44	18	5	0.040-0.042	0.042
23. chloroform (trichloromethane)	47	35	8	0.020-0.310	0.097
25. 1,2-dichlorobenzene	44	1	0	NA	NA
27. 1,4-dichlorobenzene	44	1	0	NA	NA
30. 1,2-trans-dichloroethylene	44	3	2	0.015-0.017	0.016
38. ethylbenzene	50	7	0	NA	NA
39. fluoranthene	43	1	0	NA	NA
41. 4-bromophenyl phenyl ether	44	1	0	NA	NA
44. methylene chloride (dichloromethane)	46	42	18	0.011-0.33	0.086
47. bromoform (tribromomethane)	47	10	0	NA	NA
48. dichlorobromomethane	44	18	0	NA	NA
49. trichlorofluoromethane	47	11	0	NA	NA
51. chlorodibromomethane	47	9	0	NA	NA
54. isophorone	44	2	0	NA	NA
55. naphthalene	45	1	1	0.018	0.018
57. 2-nitrophenol	44	5	0	NA	NA
58. 4-nitrophenol	44	3	0	NA	NA
61. N-nitrosodimethylamine	44	1	0	NA	NA
62. N-nitrosodiphenylamine	44	5	0	NA	NA
65. phenol	44	19	9	0.028-0.810	0.316
66. bis(2-ethylhexyl) phthalate	44	43	21	0.011-1.006	0.333
67. butyl benzyl phthalate	44	4	0	NA	NA
68. di-n-butyl phthalate	44	40	5	0.011-0.013	0.012
69. di-n-octyl phthalate	44	7	2	0.020-0.021	0.020
70. diethyl phthalate	44	25	2	0.621-0.964	0.793
71. dimethyl phthalate	44	4	1	0.087	0.087
72. benzo (a)anthracene (1,2-benzanthracene)	42	3	0	NA	NA
73. benzo (a)pyrene (3,4-benzopyrene)	44	3	1	0.012	0.012

Table VI-17 (Continued)

SUMMARY OF SAMPLE DATA

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutants	Number of Samples	Number of Times Detected	Number of Times* Detected Above Source and Method Detection Limit	Concentration Range** (mg/l)	Average Concentration** (mg/l)
76. chrysene	44	4	0	NA	NA
78. anthracene	44	6	0	NA	NA
80. fluorene	44	2	0	NA	NA
81. phenanthrene	44	4	0	NA	NA
85. tetrachloroethylene	47	8	3	0.014-0.058	0.030
86. toluene	47	18	4	0.015-0.016	0.016
87. trichloroethylene	47	9	0	NA	NA
89. aldrin	45	8	4	0-0.0007	0.0003
90. dieldrin	47	7	7	0-0.0001	41†
92. 4,4'-DDT	47	1	1	22†	22†
93. 4,4'-DDE(p,p'DDX)	47	3	3	27†-60†	44†
94. 4,4'-DDD(p,p'TDE)	47	1	1	40†	40†
96. β-endosulfan	44	1	1	0.00014	0.00014
97. endosulfan sulfate	44	1	1	13†	13†
98. endrin	44	2	0	NA	NA
99. endrin aldehyde	42	2	2	31†-66†	48.5†
100. heptachlor	44	5	4	26†-243†	203†
101. heptachlor epoxide	44	2	2	40†-382†	211†
102. α-BHC	44	22	19	3†-0.001	250†
103. β-BHC	44	13	11	16†-600†	176†
104. γ-BHC	44	16	9	0-300†	132†
105. δ-BHC	44	16	13	0-0.0068	104†
114. antimony	42	14	0	NA	NA
115. arsenic	41	3	0	NA	NA
117. beryllium	42	2	2	0.003	0.003
118. cadmium	41	19	9	0.006-0.071	0.023
119. chromium (Total)	41	15	11	0.008-0.200	0.050
120. copper	41	31	6	0.037-0.940	0.228
121. cyanide (Total)	46	44	0	NA	NA
122. lead	41	18	8	0.100-0.500	0.248
123. mercury	41	3	3	0.0003-0.0007	0.0004
124. nickel	41	11	7	0.017-3.880	0.686
125. selenium	41	11	0	NA	NA
126. silver	41	12	2	0.009-0.012	0.010
127. thallium	41	2	2	0.126	0.126
128. zinc	41	30	12	0.018-0.770	0.190

*Detected above the concentration of the pollutant in the source water and above the method detection limit for a pollutant.

**Only concentration values greater than the concentration value in the source water (i.e., plant intake water) and above the method detection limit are included in the concentration range and the average concentration.

NA - Not applicable because no data remain after editing rules were applied to the data.

†Concentration is in nanograms per liter.

Table VI-17 (Continued)

SUMMARY OF SAMPLE DATA

CLEANING AND FINISHING WATER SUBCATEGORY

Conventional Pollutants	Number of Samples	Number of Times Detected	Number of Times* Detected Above Source and Method Detection Limit	Concentration Range** (mg/l)	Average Concentration** (mg/l)
biological oxygen demand (BOD)	24	24	20	2.6-510	100
oil and grease	24	24	12	7-684	130
total suspended solids (TSS)	26	26	22	2-16,400	1,840
pH	23	NA	NA	1.6-11.5	NA
Nonconventional Pollutants					
aluminum	24	17	8	0.1-8.0	1.586
ammonia nitrogen	26	26	17	0.06-399	90
barium	24	19	17	0.012-0.8	0.094
boron	24	16	15	0.024-2.90	0.513
bromide	8	8	0	NA	NA
calcium	24	24	10	2.5-207.0	39
chemical oxygen demand (COD)	26	26	19	7-1,150	410
cyanide	20	17	0	NA	NA
fluoride	8	8	2	0.99-6.8	3.895
iron	24	21	17	0.118-51.3	6.27
Kjeldahl nitrogen	26	26	18	0.65-3,070	477
manganese	24	16	12	0.02-0.519	0.104
magnesium	24	24	9	0.8-24.9	9.3
molybdenum	24	3	3	0.021-0.3	0.171
nitrate/nitrite	8	8	2	0.28-2.1	1.19
phenols	26	26	17	0.31-730	134
tin	24	7	7	0.021-1.2	0.569
titanium	24	15	13	0.021-0.199	0.064
total dissolved solids (TDS)	20	17	14	5.0-13,000	2,177
sodium	24	24	20	2.1-3,860	323
total phosphorus	26	26	19	0.04-103.4	14.4
total organic carbon (TOC)	26	26	26	7-10,038	1,370
sulfate	8	8	4	10-45	26.8
sulfide	7	7	0	NA	NA
surfactants	25	24	12	0.04-148	18.2
yttrium	24	2	2	0.006	0.006

Table VI-17 (Continued)

SUMMARY OF SAMPLE DATA

CLEANING AND FINISHING WATER SUBCATEGORY

Priority Pollutants	Number of Samples	Number of Times Detected	Number of Times* Detected Above Source and Method Detection Limit	Concentration Range** (mg/l)	Average Concentration** (mg/l)
4. benzene	24	18	6	0.011-0.099	0.026
7. chlorobenzene	24	2	0	NA	NA
11. 1,1,1-trichloroethane	24	12	2	0.011-0.020	0.016
13. 1,1-dichloroethane	24	1	0	NA	NA
22. parachlorometa cresol	24	7	0	NA	NA
23. chloroform (trichloromethane)	24	13	3	0.035-0.053	0.045
24. 2-chlorophenol	24	1	0	NA	NA
26. 1,3-dichlorobenzene	24	1	0	NA	NA
30. 1,2-trans-dichloroethylene	24	2	0	NA	NA
31. 2,4-dichlorophenol	24	1	0	NA	NA
38. ethylbenzene	24	3	0	NA	NA
39. fluoranthene	24	8	0	NA	NA
44. methylene chloride (dichloromethane)	24	21	8	0.014-0.310	0.067
47. bromoform (tribromomethane)	24	3	0	NA	NA
48. dichlorobromomethane	24	3	2	0.011-0.015	0.013
49. trichlorofluoromethane	24	5	3	0.017-0.034	0.023
51. chlorodibromomethane	24	2	0	NA	NA
55. naphthalene	24	1	0	NA	NA
57. 2-nitrophenol	24	1	0	NA	NA
60. 4,6-dinitro-o-cresol	24	1	0	NA	NA
62. N-nitrosodiphenylamine	24	10	3	0.016-0.064	0.036
64. pentachlorophenol	24	2	0	NA	NA
65. phenol	24	20	12	0.030-6.000	1.334
66. bis(2-ethylhexyl) phthalate	24	22	10	0.011-0.140	0.059
67. butyl benzyl phthalate	24	2	0	NA	NA
68. di-n-butyl phthalate	24	16	1	0.023	0.023
69. di-n-octyl phthalate	24	1	0	NA	NA
70. diethyl phthalate	24	15	0	NA	NA
72. benzo(a)anthracene (1,2-benzoanthracene)	24	2	0	NA	NA
73. benzo(a)pyrene (3,4-benzopyrene)	24	2	0	NA	NA
76. chrysene	24	6	0	NA	NA
78. anthracene	24	5	0	NA	NA
80. fluorene	24	1	0	NA	NA
81. phenanthrene	24	4	0	NA	NA
84. pyrene	24	4	0	NA	NA

Table VI-17 (Continued)

SUMMARY OF SAMPLE DATA

CLEANING AND FINISHING WATER SUBCATEGORY

Priority Pollutants	Number of Samples	Number of Times Detected	Number of Times* Detected Above Source and Method Detection Limit	Concentration Range** (mg/l)	Average Concentration** (mg/l)
85. tetrachloroethylene	24	3	0	NA	NA
86. toluene	24	14	8	0.030-0.69	0.12
87. trichloroethylene	24	5	0	NA	NA
89. aldrin	24	4	4	0-100†	52†
90. dieldrin	24	1	0	NA	NA
97. endosulfan sulfate	24	2	0	NA	NA
98. endrin	24	2	2	0-0.0023	0.001
100. heptachlor	24	4	4	0-0.0001	18†
102. α-BHC	24	3	3	4†-6†	5†
103. β-BHC	24	3	2	10†-200†	105†
104. γ-BHC	24	6	5	0-0.0016	535†
105. δ-BHC	24	7	7	6†-500†	116†
114. antimony	24	6	2	0.105-0.133	0.119
115. arsenic	24	8	2	0.095-0.12	0.108
119. chromium (Total)	24	9	9	0.013-0.53	0.112
120. copper	24	19	11	0.010-1.440	0.401
121. cyanide (Total)	26	26	0	NA	NA
123. mercury	24	3	2	0.0003-0.0005	0.0004
124. nickel	24	3	3	0.100-0.166	0.136
125. selenium	24	8	5	0.110-0.280	0.175
126. silver	24	3	1	0.018	0.018
128. zinc	24	23	16	0.027-29.8	3.375

*Detected above the concentration of the pollutant in the source water and above the method detection limit for a pollutant.

**Only concentration values greater than the concentration values in the source water (i.e., plant intake water) and above the method detection limit are included in the concentration range and the average concentration.

NA - Not applicable because no data remain after editing rules are applied to the data.

†Concentration is in nanograms per liter.

Table VI-18

DATA EDITING RULES AND AVERAGING METHODOLOGY - EXAMPLE CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutant	Process Code§	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate	Average
23. chloroform	B-1	0.014	0.026				0.026
	B-4	0.014	0.020			0.070	0.0135
	C-1	ND	~~ND~~	~~ND~~	~~ND~~		
	D-3	0.019	~~0.010~~				
	E-1	0.068	(0.042)	(0.068)			
	E-2	0.068	(0.048)	(0.058)	0.070	0.115	0.0925
	E-3	0.068	(0.042)	0.090	(0.066)		0.090
	E-4	0.068	0.310	0.220			0.265
	F-1	*	(*)	(*)	(*)		
	F-2	*	(*)	(*)	~~ND~~		
	F-6	*		(*)	(*)		
	G-1	0.006	~~0.005~~	~~0.008~~			
	H-1	ND	~~ND~~	~~ND~~		~~ND~~	
	J-1	0.0035	~~ND~~				
	J-2	0.0035	~~ND~~			~~ND~~	
	K-2	0.1015	(*)	~~ND~~	~~ND~~		
	K-3	0.1015	~~0.001~~	~~0.002~~	~~0.002~~	~~0.003~~	
	K-4	0.1015	~~0.003~~/ (0.015)	~~0.005~~/ (0.012)	(0.029)/ (0.024)		

CONCENTRATION DATA EDITING RULES AND AVERAGING METHODOLOGY

1. Data were first eliminated because the pollutant was never detected or detected at or below the analytical detection limit. For chloroform, the analytical detection limit is 0.010 mg/l. See sample data that have a straight line through them.
2. Data were next eliminated if the source water concentrations were equal to or greater than the effluent concentrations. See sample data that are enclosed by parentheses.
3. An average process concentration for each pollutant was calculated by summing the remaining concentration values for days one, two, three, and the duplicate, and dividing by the number of values. These values are listed under the average column.
4. The subcategory average was calculated by summing the average process concentration value and dividing by the number of values. For chloroform the subcategory average is 0.097 mg/l.

   Average Concentration = (0.026 + 0.0135 + 0.0925 + 0.090 + 0.265)/5 = 0.097 mg/l

   This is the value reported in Table VI-17.
5. The subcategory range was obtained by finding the smallest and largest concentration value remaining after data editing steps one and two. The range for chloroform is 0.020-0.310 mg/l and is reported in Table VI-17.

DATA EXPLANATION

An asterisk represents a reported concentration value of less than 0.010 mg/l.

The two values listed under each sampling day for process K-4 represent values for a preserved an an unpreserved sample. Preserving a sample retains any free chlorine in the sample.

§See Figures VI-1 through VI-11 for process diagrams.

values are above the analytical detection limit for the pesticides.

The conventional and nonconventional pollutant data were edited in a similar manner. However, when a less than value was repored for those pollutants the absolute value of that value was used to calculate the averages. Less than values for the conventional and nonconventional pollutants were eliminated only if they were equal to or less than the value for that pollutant in the source water.

Less than values for the priority and nonconventional metals were often reported by the laboratory. These less than values were considered as not detected and were not used in the averaging processes. For the priority metal pollutants, when both the Task 1 (Inductively Coupled Plasma Optical) and Task 2 (Flame Atomic Absorption) analyses were performed, only the Task 1 test results were used in the averaging process.

SAMPLED PLANTS WITH WASTEWATER TREATMENT SYSTEMS

Wastewater treatment technolgies exist at four of the plants (i.e., plants C, E, F and I) that were sampled in 1980 and at one plant (i.e., plant B) sampled in 1983. Of the four 1980 plants, only Plant I had a wastewater treatment system primarily for PM&F wastewaters.

The treatment at Plant I consists of equalization, pH adjustment, and filtration. Effluent data for this treatment plant are presented in Appendix A.

The treatment system at Plants B, C, E, and F consists of a lagoon that treats a combined wastewater. Effluent from the treatment systems at Plants E and F were sampled during this project. The effluent data were not used in the data analyses for this project because the treatment system treats more than just PM&F wastewater. Those data are presented in the administrative record for the project.

SOLUTION CASTING/SOLVENT RECOVERY SAMPLING DATA

Wastewater is also generated by the solvent recovery operation in the solution or solvent casting process. However, this wastewater does not result from the blending, molding, forming, or any processing of the plastic material and is not a process water. Samples of this wastewater indicate that its pollutant characteristics are different from the characteristics of PM&F process wastewater. In addition, the Agency estimates that only eight plants in the category generate solvent recovery wastewater. For these reasons, the Agency believes that solvent recovery wastewater is best controlled on a case-by-case basis by the permit writer or control authority. Analytical data for this type of wastewater from the Agency's study of the plastics molding and forming category may be used as a guide by the permit writer. Appendix A presents wastewater pollutant characteristics for a solution casting process at Plant G. See Figure VI-7 for a process diagram.

SECTION VII

POLLUTANTS IN PLASTICS MOLDING AND FORMING WASTEWATER

The Agency studied the plastics molding and forming category to determine the presence of conventional, selected nonconventional, and priority toxic pollutants in PM&F wastewater.

CONVENTIONAL POLLUTANTS

As previously mentioned, conventional pollutants are those defined in Section 304(a)(4) of the Act and any other pollutants defined by the Administrator as conventional pollutants. The list of conventional pollutants currently includes: biochemical oxygen demand (BOD_5), total suspended solids (TSS), fecal coliform, pH, and oil and grease.

Samples collected during the 1980 and 1983 sampling episodes for this project were analyzed for BOD_5, TSS, oil and grease, and pH. All of these pollutants warrant further consideration for the control because they were found in significant concentrations in the PM&F wastewater.

NONCONVENTIONAL POLLUTANTS

Samples collected during the 1980 and 1983 sampling episodes were also analyzed for the nonconventional pollutants listed in Table VI-13. These pollutants were selected for analysis based on knowledge of the raw materials used in the PM&F category and on the potential for those pollutants to be discharged in wastewater.

Results of the sample analyses indicate that only three nonconventional pollutants were found in significant concentrations in PM&F wastewater. They are: chemical oxygen demand (COD), total organic carbon (TOC), and total phenols.

PRIORITY TOXIC POLLUTANTS

List of Pollutants

One hundred and twenty-nine priority toxic pollutants were studied in this project pursuant to the requirements of the Clean Water Act of 1977. These pollutants, which are listed in Table VI-13, are members of the 65 compounds and classes of compounds referred to in Section 307(a)(1) of the Act.

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From the original list of 129 priority pollutants, three pollutants were deleted in two separate amendments to 40 CFR Subchapter N, Part 401. Dichlorodifluoromethane and trichlorofluoromethane were deleted first (46 FR 79692; January 8, 1981) followed by the deletion of bis(chloromethyl) ether (46 FR 10723; February 4, 1981). The Agency concluded that deleting these compounds does not compromise adequate control over their discharge into the aquatic environment and that no adverse effects on the aquatic environment or on human health will occur as a result of deleting them from the list of priority toxic pollutants. Concentration data were obtained for these pollutants during this project because some of the PM&F samples were collected and analyzed prior to the deletion of these pollutants from the list of priority pollutants. These pollutants were not considered, however, further for regulation.

Data on the concentration of asbestos in PM&F wastewater are available from a small number of samples taken during the 1980 sampling plan. Those data indicate that asbestos was not present or could not be interpreted because of the limited number of fibers counted. Asbestos was not analyzed for in the 1983 sampling program.

Exclusion of Pollutants and Subcategories

The modified Settlement Agreement in *NRDC* v. *Train*, *supra*, contains provisions that authorize the exclusion of priority toxic pollutants and industry subcategories from regulation in certain instances. These provisions are presented in Paragraph 8 of the modified Settlement Agreement. They are:

"1. For a specific pollutant or a subcategory or category, equally or more stringent protection is already provided by an effluent, new source performance standard, or pretreatment standard or by an effluent limitation and guideline promulgated pursuant to Section(s) 301, 304, 306, 307(a), 307(b), and 307(c) of the Act.

2. For a specific pollutant, except for pretreatment standards, the specific pollutant is present in the effluent discharge solely as a result of its presence in intake waters taken from the same body of water into which it is discharged and, for pretreatment standards, the specific pollutant is present in the effluent which is introduced into treatment works (as defined in Section 212 of the Act) which are publicly owned solely as a result of its presence in the point source's intake waters, provided however, that such point source may be subject to an appropriate effluent limitation for such pollutant pursuant to the requirements of Section 307.

3. For a specific pollutant, the pollutant is not detectable (with the use of analytical methods approved pursuant to 304(h) of the Act, or in instances where approved methods do not exist, with the use of analytical methods which represent state-of-the-art capability) in the direct discharges or in the effluents which are introduced into publicly-owned treatment works from sources within the subcategory or category; or is detectable in the effluent from only a small number of sources within the subcategory and the pollutant is uniquely related to only those sources; or the pollutant is present only in trace amounts and is neither causing nor likely to cause toxic effects; or is present in amounts too small to be effectively reduced by technologies known to the Administrator; or the pollutant will be effectively controlled by the technologies upon which are based other effluent limitations and guidelines, standards of performance, or pretreatment standards.

4. For a category or subcategory, the amount and the toxicity of each pollutant in the discharge does not justify developing national regulations in accordance with the schedule contained in Paragraph 7(b)."

The basis for exclusion in subparagraph 2 is that if a pollutant was found in a higher concentration in the plant intake water (i.e., source water) than in the wastewater generated by the PM&F process, that pollutant would be excluded from control. Data obtained from the sampling episodes were reviewed, therefore, to determine which, if any, of the priority pollutants were excluded from control because of this reason.

With respect to subparagraph 3 for the PM&F project, a pollutant was considered not detected if the laboratory reported that it was not detected or if the laboratory reported that it was detected at or below the analytical detection limit. Pollutants were excluded from control if they were not detected or detected at or below their detection limit. Also for this project, "detected in a small number of sources" was defined as detected in two or less samples when 20 or more samples were analyzed. If a pollutant was found in two or less samples when 20 or more samples were analyzed for that pollutant, it was excluded from further consideration. In most cases when this criterion applied, the pollutant was also unique to the particular plant that was sampled.

The PM&F category was reviewed to determine if any of the priority pollutants could be excluded based on Paragraph 8 of the Settlement Agreement. Each subcategory was also reviewed to determine if any priority pollutants could be excluded by subcategory. Results of those reviews are presented below.

PM&F Category. The Agency first applied the exclusion criterion that a pollutant was not detected or was detected at or below the analytical detection limit to data for the entire category. Table VII-1 lists 75 priority toxic pollutants that were not detected in any of the wastewater samples analyzed or were detected at or below the pollutant analytical detection limit. These pollutants are excluded from regulation for the PM&F category and were not considered further. Table VII-2 lists the priority pollutants that were considered further because they were detected above their analytical detection limit.

PM&F Subcategories. Priority pollutants listed in Table VII-2 were reviewed by subcategory to determine whether:

1. A pollutant was never detected in wastewater samples for this subcategory or was detected at or below the analytical detection limit;

2. A pollutant was found in a higher concentration in the plant intake water (i.e., source water) than in the wastewater generated by the PM&F process; and

3. A pollutant was detected in two or less samples when 20 or more samples were analyzed for that pollutant.

A pollutant was first reviewed to determine if it was found above the detection limit. If it was, the data were reviewed to determine if the pollutant was present in a higher concentration in the source water than in the wastewater. If the concentration was higher in the effluent, the pollutant was examined for occurrence in more than two samples if 20 or more samples were analyzed. If the pollutant passed all of these criteria, it was considered further for possible regulation. Table VII-3 presents an example of this exclusion methodology. Table VII-4 presents priority pollutants excluded from control for the PM&F subcategories using this methodology.

POLLUTANTS CONSIDERED FURTHER

Table VII-5 lists the pollutants considered further for control by the PM&F effluent limitations guidelines and standards. Also presented in Table VII-5 are the pollutant average effluent concentrations (see Table VI-17). The conventional pollutants considered for control are BOD_5, oil and grease, TSS, and pH. The nonconventional pollutants considered further are COD, TOC, and total phenols. Twenty-eight priority pollutants were considered for control including 20 organic pollutants and eight metal pollutants.

Table VII-1

PRIORITY POLLUTANTS EXCLUDED FROM CONTROL

PRIORITY POLLUTANTS EXCLUDED FROM CONTROL FOR PM&F CATEGORY*

Priority Pollutant

1. acenaphthene
2. acrolein
3. acrylonitrile
5. benzidene
7. chlorobenzene
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene
10. 1,2-dichloroethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. chloroethane
18. bis (2-chloroethyl) ether
19. 2-chloroethyl vinyl ether (mixed)
20. 2-chloronaphthalene
21. 2,4,6-trichlorophenol
24. 2-chlorophenol
25. 1,2-dichlorobenzene
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene
28. 3,3'-dichlorobenzidine
29. 1,1-dichloroethylene
31. 2,4-dichlorophenol
32. 1,2-dichloropropane
33. 1,2-dichloropropylene (1,3-dichloropropene)
34. 2,4-dimethylphenol
35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene
37. 1,2-diphenylhydrazine
38. ethylbenzene
39. fluoranthene
40. 4-chlorophenyl phenyl ether
41. 4-bromophenyl phenyl ether
42. bis(2-chloroisopropyl) ether
43. bis(2-choroethoxy) methane
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
51. chlorodibromomethane
52. hexachlorobutadiene
53. hexachlorocyclopentadiene
54. isophorone
56. nitrobenzene
57. 2-nitrophenol
58. 4-nitrophenol
59. 2,4-dinitrophenol
60. 4,6-dinitro-o-cresol
61. N-nitrosodimethylamine
63. N-nitrosodi-n-propylamine
64. pentachlorophenol
67. butyl benzyl phthalate
72. benzo (a)anthracene (1,2-benzanthracene)
74. 3,4-benzofluoranthene
75. benzo(k)fluoranthane (11,12-benzofluoranthene)
76. chrysene
77. acenaphthylene
78. anthracene
79. benzo(ghi)perylene (1,11-benzoperylene)
80. fluorene
81. phenanthrene
82. dibenzo (a,h)anthracene (1,2,5,6-dibenzanthracene)
83. indeno (1,2,3-cd)pyrene (w,e,-o-phenylenepyrene)
84. pyrene
88. vinyl chloride (chloroethylene)
91. chlordane (technical mixture and metabolites)
95. α-endosulfan
106. PCB-1242 (Arochlor 1242)
107. PCB-1254 (Arochlor 1254)
108. PCB-1221 (Arochlor 1221)
109. PCB-1232 (Arochlor 1232)
110. PCB-1248 (Arochlor 1248)
111. PCB-1260 (Arochlor 1260)
112. PCB-1016 (Arochlor 1016)
113. toxaphene
116. asbestos
129. 2,3,7,8-tetra chlorodibenzo-p-dioxin (TCDD)

*Pollutants were either not detected in any wastewater samples or were detected at or below the pollutant analytical detection limit.

Table VII-2

PRIORITY POLLUTANTS DETECTED IN PM&F WASTEWATER

Priority Pollutant

4. benzene
6. carbon tetrachloride (tetrachloromethane)
11. 1,1,1-trichloroethane
12. hexachloroethane
22. parachlorometa cresol
23. chloroform (trichloromethane)
30. 1,2-trans-dichloroethylene
44. methylene chloride (dichloromethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane
55. naphthalene
62. N-nitrosodiphenylamine
65. phenol
66. bis(2-ethylhexyl) phthalate
68. di-n-butyl phthalate
69. di-n-octyl phthalate
70. diethyl phthalate
71. dimethyl phthalate
73. benzo (a)pyrene (3,4-benzopyrene)
85. tetrachloroethylene
86. toluene
87. trichloroethylene
89. aldrin
90. dieldrin
92. 4,4'-DDT
93. 4,4'-DDE(p,p'DDX)
94. 4,4'-DDD(p,p'TDE)
96. -endosulfan
97. endosulfan sulfate
98. endrin
99. endrin aldehyde
100. heptachlor
101. heptachlor epoxide
102. α-BHC
103. β-BHC
104. γ-BHC
105. δ-BHC
114. antimony
115. arsenic
117. beryllium
118. cadmium
119. chromium (Total)
120. copper
121. cyanide (Total)
122. lead
123. mercury
124. nickel
125. selenium
126. silver
127. thallium
128. zinc

Table VII-3

EXCLUSION METHODOLOGY EXAMPLE - POLLUTANT X

Operation	Method Detection Limit (mg/l)	Pollutant X Concentration (mg/l)					
		Source	Day 1	Day 2	Day 3	Day 4	Day 5
1	2	4	~~ND~~	(3)	~~ND~~	~~ND~~	(4)
2	2	5	(5)	~~ND~~	⑥	~~ND~~	~~ND~~
3	2	ND	~~1~~	⑦	~~ND~~	~~ND~~	~~ND~~
4	2	3	~~1~~	~~2~~	(3)	~~ND~~	~~ND~~

Exclusion Methodology

1. Data are first eliminated because the pollutant was never detected or detected at or below the analytical detection limit. See sample data that have a straight line through them.

2. Data are next eliminated if the source water concentrations are equal to or greater than the effluent concentrations. See sampled data enclosed by parentheses.

3. Data are finally eliminated if only analytical results for 2 or less samples from a total data base for 20 or more samples remain. See sample data that are circled.

Pollutant X was excluded because it was found in two or less samples after the other data were eliminated.

Table VII-4

PRIORITY POLLUTANTS EXCLUDED FROM CONTROL

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutants Not Detected or Detected at or Below the Analytical Detection Limit

48. dichlorobromomethane
62. N-nitrosodiphenylamine
98. endrin
114. antimony
115. arsenic
121. cyanide (Total)
125. selenium

Priority Pollutants with Concentrations in the Plant Intake Water Equal to or Greater Than the Effluent Concentrations

47. bromoform (tribromomethane)
87. trichloroethylene

Priority Pollutants Detected in Two or Less Samples When 20 or More Samples Were Analyzed

12. hexachloroethane
30. 1,2-trans-dichloroethylene
55. naphthalene
69. di-n-octyl phthalate
70. diethyl phthalate
71. dimethyl phthalate
73. benzo (a)pyrene (3,4-benzopyrene)
92. 4,4'-DDT
94. 4,4'-DDD(p,p'TDE)
96. β-endosulfan
97. endosulfan sulfate
99. endrin aldehyde
101. heptachlor epoxide
117. beryllium
126. silver
127. thallium

CLEANING AND FINISHING WATER SUBCATEGORY

Priority Pollutants Not Detected or Detected at or Below the Analytical Detection Limit

6. carbon tetrachloride (tetrachloromethane)
12. hexachloroethane
30. 1,2-trans-dichloroethylene
47. bromoform (tribromomethane)
55. naphthalene
69. di-n-octyl phthalate
70. diethyl phthalate
71. dimethyl phthalate
73. benzo (a)pyrene (3,4-benzopyrene)
85. tetrachloroethylene
87. trichloroethylene
90. dieldrin
92. 4,4'-DDT
93. 4,4'-DDE(p,p'DDX)
94. 4,4'-DDD(p,p'TDE)
96. β-endosulfan
97. endosulfan sulfate
99. endrin aldehyde
101. heptachlor epoxide
117. beryllium
118. cadmium
122. lead
127. thallium

Priority Pollutants with Concentrations in the Plant Intake Water Equal to or Greater Than the Effluent Concentrations

22. parachlorometa cresol
121. cyanide (Total)

Priority Pollutants Detected in Two or Less Samples When 20 or More Samples Were Analyzed

11. 1,1,1-trichloroethane
48. dichlorobromomethane
68. di-n-butyl phthalate
98. endrin
103. β-BHC
114. antimony
115. arsenic
123. mercury
126. silver

Table VII-5

POLLUTANTS CONSIDERED FOR CONTROL BY SUBCATEGORY

		Average* Concentration Contact Cooling and Heating Water (mg/l)	Average* Concentration Cleaning and Finishing Water (mg/l)
Conventional Pollutants			
	BOD_5	102	100
	Oil and Grease	21	130
	TSS	17	1,840
	pH	(5.4-8.3)	(1.6-11.5)
Nonconventional Pollutants			
	COD	241	410
	TOC	74	1,370
	Total Phenols	149	134
Priority Pollutants			
4.	benzene	0.029	0.026
6.	carbon tetrachloride (tetrachloromethane)	1.176	**
11.	1,1,1-trichloroethane	0.037	**
22.	parachlorometa cresol	0.042	**
23.	chloroform (trichloromethane)	0.097	0.045
44.	methylene chloride (dichloromethane)	0.086	0.067
62.	N-nitrosodiphenylamine	**	0.036
65.	phenol	0.316	1.334
66.	bis(2-ethylhexyl) phthalate	0.333	0.059
68.	di-n-butyl phthalate	0.012	**
85.	tetrachloroethylene	0.030	**
86.	toluene	0.016	0.120
89.	aldrin	315†	52†
90.	dieldrin	41†	**
93.	4,4'-DDE	44†	**
100.	heptachlor	203†	18†
102.	α-BHC	250†	5†
103.	β-BHC	176†	**
104.	γ-BHC	132†	534†
105.	δ-BHC	104†	116†

Table VII-5 (Continued)

POLLUTANTS CONSIDERED FOR CONTROL BY SUBCATEGORY

Priority Pollutants	Average* Concentration Contact Cooling and Heating Water (mg/l)	Average* Concentration Cleaning and Finishing Water (mg/l)
118. cadmium	0.023	**
119. chromium (Total)	0.050	0.112
120. copper	0.228	0.401
122. lead	0.248	**
123. mercury	0.0004	**
124. nickel	0.686	0.136
125. selenium	**	0.175
128. zinc	0.190	3.375

*Average concentrations presented in Table VI-17.

**Pollutant is not considered for control in this subcategory.

†Concentrations are in nanograms per liter.

The following discussions address the pollutants listed in Table VII-5. The discussions include the source of the pollutant; whether it is a naturally occurring element, processed metal, or a manufactured product; general physical properties and the form of the pollutant; and toxic effects of the pollutant on humans and other animals.

Conventional Pollutants

Biochemical Oxygen Demand (BOD_5). Biochemical oxygen demand is not a specific pollutant, but a measure of the relative oxygen requirements of wastewaters, effluents, and polluted waters. The BOD_5 test measures the oxygen required for the biochemical degradation of organic material (carbanaceous demand) and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron. It also may measure the oxygen used to oxidize reduced forms of nitrogen (nitrogenous demand) unless their oxidation is prevented by an inhibitor to prevent ammonia oxidation.

Most wastewaters contain more oxygen-demanding materials than the amount of dissolved oxygen available in air-saturated water. Therefore, it is necessary to dilute the sample, add nutrients, and maintain the pH in a range suitable for bacterial growth. Complete stabilization of a sample may require a period of incubation too long for practical purposes. Five days is the accepted standard incubation period.

Oil and Grease. Oil and grease are taken together as one pollutant parameter. Some of its components are:

1. Light Hydrocarbons - These include light fuels such as gasoline, kerosene, and jet fuel, and miscellaneous solvents used for industrial processing, degreasing, or cleaning purposes. The presence of these light hydrocarbons may make the removal of other heavier oil wastes more difficult.

2. Heavy Hydrocarbons, Fuels, and Tars - These include the crude oils, diesel oils, #6 fuel oil, residual oils, slop oils, and in some cases, asphalt and road tar.

3. Lubricants and Cutting Fluids - These generally fall into two classes: non-emulsifiable oils such as lubricating oils and greases and emulsifiable oils such as water soluble oils, rolling oils, cutting oils, and drawing compounds. Emulsifiable oils may contain fat, soap, or various other additives.

4. Vegetable and Animal Fats and Oils - These originate primarily from processing of foods and natural products.

These compounds can settle or float and may exist as solids or liquids depending on factors such as method of use, production process, and temperature of water.

Oil and grease even in small quantities cause troublesome taste and odor problems. Scum lines from these agents are produced on water treatment basin walls and other containers. Fish and water fowl are adversely affected by oils in their habitat. Oil emulsions may adhere to the gills of fish causing suffocation, and the flesh of fish is tainted when microorganisms that were exposed to waste oil are eaten. Deposition of oil in the bottom sediments of water can serve to inhibit normal benthic growth. Oil and grease exhibit an oxygen demand.

Many of the toxic organic pollutants will be found distributed between the oil phase and the aqueous phase in industrial wastewaters. The presence of phenols, PCB's, PAH's, and almost any other organic pollutant in the oil and grease make characterization of this parameter almost impossible. However, all of these other organics add to the objectionable nature of the oil and grease.

Levels of oil and grease that are toxic to aquatic organisms vary greatly, depending on the type and the species susceptibility. However, it has been reported that crude oil in concentrations as low as 0.3 mg/l is extremely toxic to freshwater fish. It has been recommended that public water supply sources be essentially free from oil and grease.

Oil and grease in quantities of 100 liters per square kilometer cause a sheen on the surface of a body of water. The presence of oil slicks decreases the aesthetic value of a waterway.

pH. Although not a specific pollutant, pH is related to the acidity or alkalinity of a wastewater. It is not, however, a measure of either. The term pH is used to describe the hydrogen ion concentration (or activity) present in a given solution. Values for pH range from 0 to 14; these numbers are the negative logarithms of the hydrogen ion concentrations. A pH of 7 indicates neutrality. Solutions with a pH above 7 are alkaline, while those solutions with a pH below 7 are acidic. The relationship of pH and acidity and alkalinity is not necessarily linear or direct. Knowledge of the water pH is useful in determining necessary measures for corrosion control, sanitation, and disinfection. Its value is also necessary in the treatment of industrial wastewaters to determine amounts of chemicals required to remove pollutants and to measure their effectiveness. Removal of pollutants, especially dissolved solids is affected by the pH of the wastewater.

Waters with a pH below 6.0 are corrosive to treatment facilities, distribution lines, and household plumbing fixtures and can thus add constituents to drinking water such as iron, copper, zinc, cadmium, and lead. The hydrogen ion concentration can affect the taste of the water; at a low pH water tastes sour. The bactericidal effect of chlorine is weakened as the pH increases, and it is advantageous to keep the pH close to 7.0. This is significant for providing safe drinking water.

Extremes of pH or rapid pH changes can exert stress conditions or kill aquatic life outright. Even moderate changes from acceptable criteria limits of pH are deleterious to some species.

The relative toxicity to aquatic life of many materials is increased by changes in the water pH. For example, metallocyanide complexes can increase a thousand-fold in toxicity with a drop of 1.5 pH units.

Because of the universal nature of pH and its effect on water quality and treatment, it is selected as a pollutant parameter for many industry categories. A neutral pH range (approximately 6 to 9) is generally desired because either extreme beyond this range has a deleterious effect on receiving waters or the pollutant nature of other wastewater constituents.

Total Suspended Solids (TSS). Suspended solids include both organic and inorganic materials. The inorganic compounds include sand, silt, and clay. The organic fraction includes such materials as grease, oil, tar, and animal and vegetable waste products. These solids may settle out rapidly; bottom deposits are often a mixture of both organic and inorganic solids. Solids may be suspended in water for a time and then settle to the bed of the stream or lake. These solids discharged with man's wastes may be inert, slowly biodegradable materials, or rapidly decomposable substances. While in suspension, suspended solids increase the turbidity of the water, reduce light penetration, and impair the photosynthetic activity of aquatic plants.

Suspended solids in water interfere with many industrial processes and cause foaming in boilers and incrustations on equipment exposed to such water, especially as the temperature rises. They are undesirable in process water used in the manufacture of steel, in the textile industry, in laundries, in dyeing, and in cooling systems.

Solids in suspension are aesthetically displeasing. When they settle to form sludge deposits on the stream or lake bed, they often damage the life in the water. Solids, when transformed to sludge deposit, may do a variety of damaging things, including blanketing the stream or lake bed and thereby destroying the living spaces for those benthic organisms that would otherwise occupy the habitat. When of an organic nature, solids use a portion or all of the dissolved oxygen available in the area. Organic materials also serve as a food source for sludgeworms and associated organisms.

Disregarding any toxic effect attributable to substances leached out by water, suspended solids may kill fish and shellfish by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids are inimical to aquatic life because they screen out light, and they promote and maintain the development of noxious conditions through oxygen depletion. This results in the killing of fish and fish food organisms. Suspended solids also reduce the recreational value of the water.

Nonconventional Pollutants

Chemical Oxygen Demand (COD). The COD is a test that measures the content of organic matter in wastewater by chemical oxidation. It is not a measure of one particular pollutant. The oxygen equivalent (i.e., carbon dioxide, CO_2) of the organic matter that can be oxidized is measured by using a strong chemical oxidizing agent in an acidic medium. Potassium dichromate is an excellent oxidizing agent for this test. The principal reaction using dichromate as the oxidizing agent may be generally represented by the following unbalanced equation:

$$\text{Organic Matter } (C_aH_bO_c) + Cr_2O_7^{=} + H^+ \xrightarrow[\text{heat}]{\text{catalyst}} Cr^{3+} + CO_2 + H_2O$$

The COD of wastewater is usually higher than the BOD_5 test because more compounds can be chemically oxidized than can be biologically oxidized. COD can be correlated with BOD_5 for many kinds of wastewater. This can be quite useful as the COD test results can be obtained in three hours versus five days for BOD_5 test results.

Total Organic Carbon (TOC). TOC is another test method to determine the organic matter present in water and it is especially applicable to small concentrations of organic matter. The test is performed by injecting a known quantity of sample into a high-temperature furnace. The organic carbon is oxidized to carbon dioxide in the presence of a catalyst and the carbon dixoide is quantitatively measured with an infrared analyzer. TOC is also not a measure of only one pollutant.

Phenols (Total). Total phenols is the result of analysis using the 4-AAPp (4-aminoantipyrene) method. This analytical procedure measures the color development of reaction products between 4-AAP and some phenols. The results are reported as phenol. Thus, "total phenols" is not total phenols because many phenols (notably nitrophenols) do not react. Also, since each reacting phenol contributes to the color development to a different degree, and each phenol has a molecular weight different from others and from phenol itself, analyses of several mixtures containing the same total concentration of several phenols will give different numbers depending on the proportions in the particular mixture.

Despite these limitations of the analytical method, total phenols is a useful parameter when the mix of phenols is relatively constant and an inexpensive monitoring method is desired. In any given plant or even in an industry subcategory, monitoring of "total phenols" provides an indication of the concentration of this group of priority pollutants as well as those phenols not selected as priority pollutants. A further advantage is that the method is widely used in water quality determinations.

It must be recognized, however, that six of the eleven priority pollutant phenols could be present in high concentrations and not be detected. Conversely, it is possible, but not probable, to have a high "total phenols" concentration without any phenol itself or any of the ten other priority pollutant phenols present. A characterization of the phenol mixture to be monitroed to establish constancy of composition will allow "total phenols" to be used with confidence.

Priority Pollutants

4. Benzene. Benzene (C_6H_6) is a clear, colorless liquid obtained mainly from petroleum feedstocks by several different processes. Some is recovered from light oil obtained from coal carbonization gases. It boils at 80°C and has a vapor pressure of 100 mm of mercury at 26°C. It is slightly soluble in water (1.8 g/l at 25°C) and it dissolves in hydrocarbon solvents. Annual production in the United States is three to four million tons.

Most of the benzene used in the United States goes into chemical manufacture. About half of that is converted to ethylbenzene which is used to make styrene. Some benzene is used in motor fuels.

Benzene is harmful to human health, according to numerous published studies. Most studies relate effects of inhaled benzene vapors. These effects include nausea, loss of muscle coordination, and excitement, followed by depression and coma. Death is usually the result of respiratory or cardiac failure. Two specific blood disorders are related to benzene exposure. One of these, acute myelogenous leukemia, represents a carcinogenic effect of benzene. However, most human exposure data are based on exposure in occupational settings and benzene carcinogenesis is not considered to be firmly established.

Oral administration of benzene to laboratory animals produced leukopenia, a reduction in the number of leukocytes in the blood. Subcutaneous injection of benzene-oil solutions has produced suggestive, but not conclusive, evidence of benzene carcinogenesis.

Benzene demonstrated teratogenic effects in laboratory animals, and mutagenic effects in humans and other animals.

For maximum protection of human health from the potential carcinogenic effects of exposure to benzene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of benzene estimated to result in additional lifetime cancer risk at levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.000066 mg/l, 0.00066 mg/l, and 0.0066 mg/l, respectively.

6. Carbon Tetrachloride. Carbon tetrachloride (CCl_4), also called tetrachloromethane, is a colorless liquid produced primarily by the chlorination of hydrocarbons - particularly methane. Carbon tetrachloride boils at 77°C and has a vapor pressure of 90 mm of mercury at 20°C. It is slightly soluble in water (0.8 gm/l at 25°C) and soluble in many organic solvents. Approximately one-third of a million tons is produced annually in the United States.

Carbon tetrachloride, which was displaced by perchloroethylene as a dry cleaning agent in the 1930's, is used principally as an intermediate for production of chlorofluoromethanes for refrigerants, aerosols, and blowing agents. It is also used as a grain fumigant.

Carbon tetrachloride produces a variety of toxic effects in humans. Ingestion of relatively large quantities - greater than five grams - has frequently proved fatal. Symptoms are burning sensation in the mouth, esophagus, and stomach, followed by abdominal pains, nausea, diarrhea, dizziness, abnormal pulse, and coma. When death does not occur immediately, liver and kidney damage are usually found. Symptoms of chronic poisoning are not as well defined. General fatigue, headache, and anxiety have been observed, accompanied by digestive tract and kidney discomfort or pain.

Data concerning teratogenicity and mutagenicity of carbon tetrachloride are scarce and inconclusive. However, carbon tetrachloride has been demonstrated to be carcinogenic in laboratory animals. The liver was the target organ.

For maximum protection of human health from the potential carcinogenic effects of exposure to carbon tetrachloride through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of carbon tetrachloride estimated to result in additional lifetime cancer risk at risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.00004 mg/l, 0.0004 mg/l, and 0.004 mg/l, respectively.

11. 1,1,1-Trichloroethane. 1,1,1-Trichloroethane is one of the two possible trichlorethanes. It is manufactured by hydrochlorinating vinyl chloride to 1,1-dichloroethane which is then chlorinated to the desired product. 1,1,1-Trichloroethane is a liquid at room temperature with a vapor pressure of 96 mm of mercury at 20°C and a boiling point of 74°C. Its formula is CCl_3CH_3. It is slightly soluble in water (0.48 g/l) and is very soluble in organic solvents. The United States annual production is greater than one-third of a million tons. 1,1,1-Trichloroethane is used as an industrial solvent and degreasing agent.

Most human toxicity data for 1,1,1-trichloroethane relates to inhalation and dermal exposure routes. Limited data are available for determining toxicity of ingested 1,1,1-trichloroethane, and those data are all for the compound itself, not solutions in water. No data are available regarding its toxicity to fish and aquatic organisms. For the protection of human health from the toxic properties of 1,1,1-trichloroethane ingested through the comsumption of water and fish, the ambient water criterion is 18.4 mg/l. The criterion is based on bioassays for possible carcinogenicity.

22. Para-chloro-meta-cresol. Para-chloro-meta-cresol (ClC_7H_6OH) is thought to be a 4-chloro-3-methyl-phenol (4-chloro-meta-cresol, or 2-chloro-5-hydroxy-toluene), but is also used by some authorities to refer to 6-chloro-3-methyl-phenol (6-chloro-meta-cresol, or 4-chloro-3-hydroxy-toluene), depending on whether the chlorine is considered to be para to the methyl or to the hydroxy group. It is assumed for the purposes of this document that the subject compound is 2-chloro-5-hydroxy-toluene. This compound is a colorless crystalline solid melting at 66 to 68°C. It is slightly soluble in water and soluble in organic solvents. This phenol reacts with 4-aminoantipyrene to give a colored product and therefore contributes to the non-conventional pollutant parameter designated "Total Phenols." No information on manufacturing methods or volumes produced was found.

Para-chloro-meta cresol (abbreviated here as PCMC) is marketed as a microbicide, and was proposed as an antiseptic and disinfectant more than 40 years ago. It is used in glues, gums, paints, inks, textiles, and leather goods.

Although no human toxicity data are available for PCMC, studies on laboratory animals have demonstrated that this compound is toxic when administered subcutaneously and intravenously. Death was preceded by severe muscle tremors. At high dosages kidney damage occurred. On the other hand, an unspecified isomer of chlorocresol, presumed to be PCMC, is used at a concentration of 0.15 percent to preserve mucous heparin, a natural product administered intravenously as an anticoagulant. The report does not indicate the total amount of PCMC typically received. No information was found regarding possible teratogenicity, or carcinogenicity of PCMC.

23. Chloroform. Chloroform, also called trichloromethane, is a colorless liquid manufactured commercially by chlorination of methane. Careful control of conditions maximizes chloroform production, but other products must be separated. Chloroform boils at 61°C and has a vapor pressure of 200 mm of mercury at 25°C. It is slightly soluble in water (8.22 g/l at 20°C) and readily soluble in organic solvents.

Chloroform is used as a solvent and to manufacture refrigerants, pharmaceuticals, plastics, and anesthetics. It is seldom used as an anesthetic.

Toxic effects of chloroform on humans include central nervous system depression, gastrointestinal irritation, liver and kidney damage and possible cardiac sensitization to adrenalin. Carcinogenicity has been demonstrated for chloroform on laboratory animals.

For the maximum protection of human health from the potential carcinogenic effects of exposure to chloroform through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of chloroform estimated to result in additional lifetime cancer risks at the levels of 10^{-7}, 10^{-6}, and 10^{-5} were 0.000019 mg/l, 0.00019 mg/l, and 0.0019 mg/l, respectively.

44. Methylene Chloride. Methylene chloride, also called dichloromethane (CH_2Cl_2), is a colorless liquid manufactured by chlorination of methane or methyl chloride followed by separation from the higher chlorinated methanes formed as coproducts. Methylene chloride boils at 40°C, and has a vapor pressure of 362 mm of mercury at 20°C. It is slightly soluble in water (20 g/l

at 20°C), and very soluble in organic solvents. The United States annual production is about 250,000 tons.

Methylene chloride is a common industrial solvent found in insecticides, metal cleaners, paint, and paint and varnish removers.

Methylene chloride is not generally regarded as highly toxic to humans. Most human toxicity data are for exposure by inhalation. Inhaled methylene chloride acts as a central nervous system depressant. There is also evidence that the compound causes heart failure when large amounts are inhaled.

Methylene chloride does produce mutation in tests for this effect. In addition, a bioassay recognized for its extremely high sensitivity to strong and weak carcinogens produced results that were marginally significant. Thus potential carcinogenic effects of methylene chloride are not confirmed or denied, but are under continuous study. These studies are difficult to conduct for two reasons. First, the low boiling point (40°C) of methylene chloride makes it difficult to maintain the compound at 37°C during incubation. Secondly, all impurities must be removed because the impurities themselves may be carcinogenic. These complications also make the test results difficult to interpret.

62. N-nitrosodiphenylamine. N-nitrosodiphenylamine [$(C_6H_5)_2NNO$], also called nitrous diphenylamide, is a yellow crystalline solid manufactured by nitrosation of diphenylamine. It melts at 66°C and is insoluble in water, but soluble in several organic solvents other than hydrocarbons. Production in the United States has approached 1,500 tons per year. The compound is used as a retarder for rubber vulcanization and as a pesticide for control of scorch (a fungus disease of plants).

N-nitroso compounds are acutely toxic to every animal species tested and are also poisonous to humans. N-nitrosodiphenylamine toxicity in adult rats lies in the mid range of the values for 60 N-nitroso compounds tested. Liver damage is the principal toxic effect. N-nitrosodiphenylamine, unlike many other N-nitrosoamines, does not show mutagenic activity. N-nitrosodiphenylamine has been reported by several investigations to be non-carcinogenic. However, the compound is capable of trans-nitrosation and could thereby convert other amines to carcinogenic N-nitrosoamines. Sixty-seven of 87 N-nitrosoamines studied were reported to have carcinogenic activity. No water quality criterion have been proposed for N-nitrosodiphenylamine.

66-71. Phthalate Esters. Phthalic acid, or 1,2-benzenedicarboxylic acid, is one of three isomeric benzenedicarboxylic acids produced by the chemical industry. The other two isomeric forms are called isophthalic and terephthalic acids. The formula for all three acids is $C_6H_4(COOH)_2$. Some esters of phthalic acid are designated as toxic pollutants. They will be discussed as a group here, and specific properties of individual phthalate esters in PM&F wastewater will be discussed afterwards.

Phthalic acid esters are manufactured in the United States at an annual rate in excess of one billion pounds. They are used as plasticizers - primarily in the production of polyvinyl chloride (PVC) resins. The most widely used phthalate plasticizer is bis (2-ethylhexyl) phthalate (66) which accounts for nearly one-third of the phthalate esters produced. This particular ester is commonly referred to as dioctyl phthalate (DOP) and should not be confused with one of the less used esters, di-n-octyl phthalate (69), which is also used as a plasticizer. In addition to these two isomeric dioctyl phthalates, four other esters, also used primarily as plasticizers, are designated as toxic pollutants. They are: butyl benzyl phthalate (67), di-n-butyl phthalate (68), diethyl phthalate (70), and dimethyl phthalate (71).

Industrially, phthalate esters are prepared from phthalic anhydride and the specific alcohol to form the ester. Some evidence is available suggesting that phthalic acid esters also may be synthesized by certain plant and animal tissues. The extent to which this occurs in nature is not known.

Phthalate esters used as plasticizers can be present in concentrations up to 60 percent of the total weight of the PVC plastic. The plasticizer is not linked by primary chemical bonds to the PVC resin. Rather, it is locked into the structure of intermeshing polymer molecules and held by van der Waals forces. The result is that the plasticizer is easily extracted. Plasticizers are responsible for the odor associated with new plastic toys or flexible sheet that has been contained in a sealed package.

Although the phthalate esters are not soluble or are only very slightly soluble in water, they do migrate into aqueous solutions placed in contact with the plastic. Thus, industrial facilities with tank linings, wire and cable coverings, tubing, and sheet flooring of PVC are expected to discharge some phthalate esters in their raw waste. In addition to their use as plasticizers, phthalate esters are used in lubricating oils and pesticide carriers. These also can contribute to industrial discharge of phthalate esters.

From the accumulated data on acute toxicity in animals, phthalate esters may be considered as having a rather low order of toxicity. Human toxicity data are limited. It is thought that the toxic effect of the esters is most likely due to one of the metabolic products, in particular the monoester. Oral acute toxicity in animals is greater for the lower molecular weight esters than for the higher molecular weight esters.

Orally administered phthalate esters generally produced enlarging of liver and kidney, and atrophy of testes in laboratory animals. Specific esters produced enlargement of heart and brain, spleenitis, and degeneration of central nervous system tissue.

Subacute doses administered orally to laboratory animals produced some decrease in growth and degeneration of the testes. Chronic studies in animals showed similar effects to those found in acute and subacute studies, but to a much lower degree. The same organs were enlarged, but pathological changes were not usually detected.

A recent study of several phthalic esters produced suggestive but not conclusive evidence that dimethyl and diethyl phthalates have a cancer liability. Only four of the six toxic pollutant esters were included in the study. Phthalate esters do bioconcentrate in fish. The factors, weighted for relative consumption of various aquatic and marine food groups, are used to calculate ambient water quality criteria for four phthalate esters. The values are included in the discussion of the specific esters.

Studies of toxicity of phthalate esters in freshwater and salt water organisms are scarce. A chronic toxicity test with bis(2-ethylhexyl) phthalate showed that significant reproductive impairment occurred at 0.003 mg/l in the freshwater crustacean, Daphnia magna. In acute toxicity studies, saltwater fish and organisms showed sensitivity differences of up to eight-fold to butyl benzyl, diethyl, and dimethyl phthalates. This suggests that each ester must be evaluated individually for toxic effects.

66. Bis(2-ethylhexyl) phthalate. In addition to the general remarks and discussion on phthalate esters, specific information on bis(2-ethylhexyl) phthalate is provided. Little information is available about the physical properties of bis(2-ethylhexyl) phthalate. It is a liquid boiling at 387°C at 5mm of mercury and is insoluble in water. Its formula is $C_6H_4(COOC_8H_{17})_2$. This toxic pollutant constitutes about one-third of the phthalate ester production in the U.S. It is commonly referred to as dioctyl phthalate, or DOP, in the plastics industry where it is the most extensively used compound for the plasticization of polyvinyl chloride (PVC). Bis(2-ethylhexyl) phthalate has been approved by the FDA for use in plastics in contact with food. Therefore, it may be found in wastewaters coming in contact with discarded plastic food wrappers as well as the PVC films and shapes normally found in industrial plants. This toxic pollutant is also a commonly used organic diffusion pump oil, where its low vapor pressure is an advantage.

For the protection of human health from the toxic properties of bis(2-ethylhexyl) phthalate ingested through water and through contaminated aquatic organisms, the ambient water quality criterion is determined to be 15 mg/l. If contaminated aquatic organisms alone are consumed, excluding the consumption of water, the ambient water criteria is determined to be 50 mg/l.

68. Di-n-butyl Phthalate. In addition to the general remarks and discussion on phthalate esters, specific information on di-n-butyl phthalate (DBP) is provided. DBP is a colorless, oily liquid, boiling at 340°C. Its water solubility at room temperature is reported to be 0.4 g/l and 4.5 g/l in two different chemistry handbooks. The formula for DBP, $C_6H_4(COOC_4H_9)_2$ is the same as for its isomer, di-isobutyl phthalate. DBP production is one to two percent of total United States phthalate ester production.

Dibutyl phthalate is used to a limited extent as a plasticizer for polyvinyl chloride (PVC). It is not approved for contact with food. It is used in liquid lipsticks and as a diluent for polysulfide dental impression materials. DBP is used as a plasticizer for nitrocellulose in making gun powder, and as a fuel in solid propellants for rockets. Further uses are insecticides, safety glass manufacture, textile lubricating agents, printing inks, adhesives, paper coatings, and resin solvents.

For protection of human health from the toxic properties of dibutyl phthalate ingested through water and through contaminated aquatic organisms, the ambient water quality criterion is determined to be 34 mg/l. If contaminated aquatic organisms alone are consumed, excluding the consumption of water, the ambient water criterion is 154 mg/l.

85. Tetrachloroethylene. Tetrachloroethylene (CCl_2CCl_2), also called perchloroethylene and PCE, is a colorless, nonflammable liquid produced mainly by two methods - chlorination and pyrolysis of ethane and propane, and oxychlorination of dichloroethane. The United States annual production exceeds 300,000 tons. PCE boils at 121°C and has a vapor pressure of 19 mm of mercury at 20°C. It is insoluble in water but soluble in organic solvents.

Approximately two-thirds of the United States production of PCE is used for dry cleaning. Textile processing and metal degreasing, in equal amounts consume about one-quarter of the United States production.

The principal toxic effect of PCE on humans is central nervous system depression when the compound is inhaled. Headache, fatigue, sleepiness, dizziness, and sensations of intoxication are reported. Severity of effects increases with vapor concentration. High integrated exposure (concentration times duration) produces kidney and liver damage. Very limited data on PCE ingested by laboratory animals indicate liver damage occurs when PCE is administered by that route. PCE tends to distribute to fat in mammalian bodies.

One report found in the literature suggests, but does not conclude, that PCE is teratogenic. PCE has been demonstrated to be a liver carcinogen in B6C3-F1 mice.

For the maximum protection of human health from the potential carcinogenic effects of exposure to tetrachlorethylene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of tetrachloroethylene estimated to result in additional lifetime cancer risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.00008 mg/l, 0.0008 mg/l, and 0.008 mg/l, respectively.

86. Toluene. Toluene is a clear, colorless liquid with a benzene-like odor. It is a naturally occuring compound derived primarily from petroleum or petrochemical processes. Some toluene is obtained from the manufacture of metallurgical coke. Toluene is also referred to as totuol, methylbenzene, methacide, and phenylmethane. It is an aromatic hydrocarbon with the formula $C_6H_5CH_3$. It boils at 111°C and has a vapor pressure of 30 mm Hg at room temperature. The water solubility of toluene is 535 mg/l, and it is miscible with a variety of organic solvents. Annual production of toluene in the United States is greater than two million metric tons. Approximately two-thirds of the toluene is converted to benzene and the remaining 30 percent is divided approximately equally into chemical manufacture, and use as a paint solvent and aviation gasoline additive. An estimated 5,000 metric tons is discharged to the environment anually as a constituent in wastewater.

Most data on the effects of toluene in human and other mammals have been based on inhalation exposure or dermal contact studies. There appear to be no reports of oral administration of toluene to human subjects. A long term toxicity study on female rats revealed no adverse effects on growth, mortality, appearance and behavior, organ to body weight ratios, blood-urea nitrogen levels, bone marrow counts, peripheral blood counts, or morphology of major organs. The effects of inhaled toluene on the central nervous system, both at high and low concentrations, have been studied in humans and animals. However, ingested toluene is expected to be handled differently by the body because it is absorbed more slowly and must first pass through the liver before reaching the nervous system. Toluene is extensively and rapidly metabolized in the liver. One of the principal metabolic products of toluene is benzoic acid, which itself seems to have little potential to produce tissue injury.

Toluene does not appear to be teratogenic in laboratory animals or man. Nor is there any conclusive evidence that toluene is mutagenic. Toluene has not been demonstrated to be positive in any in vitro mutagenicity or carcinogenicity bioassay system, nor to be carcinogenic in animals or man.

Toluene has been found in fish caught in harbor waters in the vicinity of petroleum and petrochemical plants. Bioconcentration studies have not been conducted, but bioconcentration factors have been calculated on the basis of the octanol-water partition coefficient.

For the protection of human health from the toxic properties of toluene ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 14.3 mg/l. If contaminated aquatic organisms alone are consumed excluding the consumption of water, the ambient water criterion is 424 mg/l. Available data show that the adverse effects on aquatic life occur at concentrations as low as 5 mg/l.

Acute toxicity tests have been conducted with toluene and a variety of freshwater fish and Daphnia magna. The latter appears to be significantly more resistant than fish. No test results have been reported for the chronic effects of toluene on freshwater fish or invertebrate species.

89. Aldrin. Aldrin is highly toxic by ingestion and inhalation, and is absorbed through the skin. It has been found to be carcinogenic to the liver of mice. For the protection of human health against the carcinogenic properties of aldrin, EPA has proposed a limit of 4.6×10^{-3} ng/l at a risk factor of 10^{-6} for the ingestion of water and contaminated aquatic organisms. Aldrin is regulated under Section 307(a), and is banned from manufacture and use by EPA.

90. Dieldrin. Dieldrin is highly toxic by ingestion, inhalation, and skin absorption. Dieldrin has been found to cause cancer in the liver of mice. Dieldrin is regulated under Section 307(a), and is banned from manufacture and use by EPA.

93. 4,4'-DDE. DDE is significantly more stable than DDT and results in more serious consequences that DDT. Evidence exists to suggest that it cause cancer of the liver in mice.

100. Heptachlor. Heptachlor is a nonsystemic stomach and contact insecticide which has fumigant action. It is a soft waxy solid with a melting range of 46 to 75°C and is practically insoluble in water. Heptachlor is very toxic to mammals with an acute oral LD50 of 100 mg/kg for male rats and an acute dermal LD50 for male rats of 195 mg/kg. Heptachlor and its epoxide bioaccumulate in fatty tissue and persist for lengthy periods of

time. Several uses of hepatachlor have been discontinued to avoid contamination of milk and animal products. Heptachlor is a suspected carcinogen. The total number of tumors in both male and female rats increased in one long-term study after heptachlor exposure. It has been recommended that human daily intake of heptachlor should not exceed 0.005 mg/kg of body weight. A ban was placed on heptachlor in Canada in 1969 because of concern for residues in milk and deleterious effects on birds.

102. α-BHC. α-BHC is toxic by ingestion, skin absorption, is an eye and skin irritant, and a central nervous system depressant.

103. β-BHC. β-BHC is moderately toxic by inhalation, highly toxic by ingestion, and is a strong irritant by skin absorption. It acts as a central nervous system depressant.

104. γ-BHC. γ-BHC, also known as lindane, is highly toxic by ingestion and moderately toxic by inhalation.

105. δ-BHC. δ-BHC is moderately toxic by inhalation and highly toxic by ingestion. It is a strong irritant to the skin and eyes, is absorbed by the skin, and is a central nervous system depressant.

118. Cadmium. Cadmium is a relatively rare metallic element that is seldom found in sufficient quantities in a pure state to warrant mining or extraction from the earth's surface. It is found in trace amounts of about 1 ppm throughout the earth's crust. Cadmium is, however, a valuable by-product of zinc production.

Cadmium is used primarily as an electroplated metal, and is found as an impurity in the secondary refining of zinc, lead, and copper.

Cadmium is an extremely dangerous cumulative toxicant, causing progressive chronic poisoning in mammals, fish, and probably other organisms. The metal is not excreted.

Toxic effects of cadmium on man have been reported from throughout the world. Cadmium may be a factor in the development of such human pathological conditions as kidney disease, testicular tumors, hypertension, arteriosclerosis, growth inhibition, chronic disease of old age, and cancer. Cadmium is normally ingested by humans through food and water as well as by breathing air contaminated by cadmium dust. Cadmium is cumulative in the liver, kidney, pancreas, and thyroid of humans and other animals. A severe bone and kidney syndrome known as itai-itai disease has been documented in Japan as caused by cadmium ingestion via drinking water and contaminated irrigation water. Ingestion of as little as 0.6 mg/day has produced the disease. Cadmium acts synergistically with other metals. Copper and zinc substantially increase its toxicity.

Cadmium is concentrated by marine organisms, particularly molluscs, which accumulate cadmium in calcareous tissues and in the viscera. A concentration factor of 1,000 for cadmium in fish muscle has been reported, as have concentration factors of 3,000 in marine plants and up to 29,600 in certain marine animals. The eggs and larvae of fish are apparently more sensitive than adult fish to poisoning by cadmium, and crustaceans appear to be more sensitive than fish eggs and larvae.

For the protection of human health from the toxic properties of cadmium ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.010 mg/l. Available data show that adverse effects on aquatic life occur at concentrations in the same range as those cited for human health, and they are highly dependent on water hardness.

119. Chromium. Chromium is an elemental metal usually found as a chromite ($FeO.Cr_2O_3$). The metal is normally produced by reducing the oxide with aluminum. A significant proportion of the chromium used is in the form of compounds such as sodium dichromate (Na_2CrO_4), and chromic acid (CrO_3) - both are hexavalent chromium compounds.

Chromium is found as an alloying component of many steels and its compounds are used in electroplating baths, and as corrosion inhibitors for closed water circulation systems.

The two chromium forms most frequently found in industry wastewaters are hexavalent and trivalent chromium. Hexavalent chromium is the form used for metal treatments. Some of it is reduced to trivalent chromium as part of the process reaction. The raw wastewater containing both valence states is usually treated first to reduce remaining hexavalent to trivalent chromium, and second to precipitate the trivalent form as the hydroxide. The hexavalent form is not removed by lime treatment.

Chromium, in its various valence states, is hazardous to man. It can produce lung tumors when inhaled, and induces skin sensitizations. Large doses of chromates have corrosive effects on the intestinal tract and can cause inflammation of the kidneys. Hexavalent chromium is a known human carcinogen. Levels of chromate ions that show no effect in man appear to be so low as to prohibit determination, to date.

The toxicity of chromium salts to fish and other aquatic life varies widely with the species, temperature, pH, valence of the chromium, and synergistic or antagonistic effects, especially the effect of water hardness. Studies have shown that trivalent chromium is more toxic to fish of some types than is hexavalent chromium. Hexavalent chromium retards growth of one fish species at 0.0002 mg/l. Fish food organisms and other lower forms of aquatic life are extremely sensitive to chromium. Therefore, both hexavalent and trivalent chromium must be considered harmful to particular fish or organisms.

For the protection of human health from the toxic properties of chromium (except hexavalent chromium) ingested through water and contaminated aquatic organisms, the ambient water quality criterion is 170 mg/l. If contaminated aquatic organisms alone are consumed, excluding the consumption of water, the ambient water criterion for trivalent chromium is 3,443 mg/l. The ambient water quality criterion for hexavalent chromium is recommended to be identical to the existing drinking water standard for total chromium which is 0.050 mg/l.

120. Copper. Copper is a metallic element that sometimes is found free, as the native metal, and is also found in minerals such as cuprite (Cu_2O), malechite [$CuCO_3.Cu(OH)_2$], azurite [$2CuCO_3.Cu(OH)_2$], chalcopyrite ($CuFeS_2$), and bornite (Cu_5FeS_4). Copper is obtained from these ores by smelting, leaching, and electrolysis. It is used in the plating, electrical, plumbing, and heating equipment industries, as well as in insecticides and fungicides.

Traces of copper are found in all forms of plant and animal life, and the metal is an essential trace element for nutrition. Copper is not considered to be a cumulative systemic poison for humans as it is readily excreted by the body, but it can cause symptoms of gastroenteritis, with nausea and intestinal irritations, as relatively low dosages. The limiting factor in domestic water supplies is taste. To prevent this adverse organoleptic effect of copper in water, a criterion of 1 mg/l has been established.

The toxicity of copper to aquatic organisms varies significantly, not only with the species, but also with the physical and chemical characteristics of the water, including temperature, hardness, turbidity, and carbon dioxide content. In hard water, the toxicity of copper salts may be reduced by the precipitation of copper carbonate or other insoluble compounds. The sulfates of copper and zinc, and of copper and calcium are synergistic in their toxic effect on fish.

Relatively high concentrations of copper may be tolerated by adult fish for short periods of time; the critical effect of copper appears to be its higher toxicity to young or juvenile fish. Concentrations of 0.02 to 0.03 mg/l have proved fatal to some common fish species. In general the salmonoids are very sensitive and the sunfishes are less sensitive to copper.

The recommended criterion to protect freshwater aquatic life is 0.0056 mg/l as a 24-hour average, and 0.012 mg/l maximum concentration at a hardness of 50 mg/l $CaCO_3$. For total recoverable copper the criterion to protect freshwater aquatic life is 0.0056 mg/l as a 24-hour average.

Copper salts cause undesirable color reactions in the food industry and cause pitting when deposited on some other metals such as aluminum and galvanized steel. To control undesirable taste and odor quality of ambient water due to the organoleptic properties of copper, the estimated level is 1.0 mg/l for total recoverable copper.

Irrigation water containing more than minute quantities of copper can be detrimental to certain crops. Copper appears in all soils, and its concentration ranges from 10 to 80 ppm. In soils, copper occurs in association with hydrous oxides of manganese and iron, and also as soluble and insoluble complexes with organic matter. Copper is essential to the life of plants, and the normal range of concentration in plant tissue is from 5 to 20 ppm. Copper concentrations in plants normally do not build up to high levels when toxicity occurs. For example, the concentrations of copper in snapbean leaves and pods was less than 50 and 20 mg/kg, respectively, under conditions of severe copper toxicity. Even under conditions of copper toxicity, most of the excess copper accumulates in the roots; very little is moved to the aerial part of the plant.

122. Lead. Lead is a soft, malleable, ductile, blueish-gray, metallic element, usually obtained from the mineral galena (lead sulfide, PbS), anglesite (lead sulfate, $PbSO_4$), or cerussite (lead carbonate, $PbCO_3$). Because it is usually associated with minerals of zinc, silver, copper, gold, cadmium, antimony, and arsenic, special purification methods are frequently used before and after extraction of the metal from the ore concentrate by smelting.

Lead is widely used for its corrosion resistance, sound and vibration absorption, low melting point (solders), and relatively high imperviousness to various forms of radiation. Small amounts of copper, antimony and other metals can be alloyed with lead to achieve greater hardness, stiffness, or corrosion resistance than is afforded by the pure metal. Lead compounds are used in glazes and paints. About one third of U.S. lead consumption goes into storage batteries. About half of U.S. lead consumption is from secondary lead recovery. U.S. consumption of lead is in the range of one million tons annually.

Lead ingested by humans produces a variety of toxic effects including impaired reproductive ability, disturbances in blood chemistry, neurological disorders, kidney damage, and adverse cardiovascular effects. Exposure to lead in the diet results in permanent increase in lead levels in the body. Most of the lead entering the body eventually becomes localized in the bones where it accumulates. Lead is a carcinogen or cocarcinogen in some species of experimental animals. Lead is teratogenic in experimental animals. Mutagenicity data are not available for lead.

The ambient water quality criterion for lead is recommended to be identical to the existng drinking water standard which is 0.050 mg/l. Available data show that adverse effects on aquatic life occur at concentrations as low as 7.5×10^{-4} mg/l of total recoverable lead as a 24-hour average with a water hardness of 50 mg/l as $CaCO_3$.

123. Mercury. Mercury is an elemental metal rarely found in nature as the free metal. Mercury is unique among metals as it remains a liquid down to about 39 degrees below zero. It is relatively inert chemically and is insoluble in water. The principal ore is cinnabar (HgS).

Mercury is used industrially as the metal and as mercurous and mercuric salts and compounds. Mercury is used in several types of batteries. Mercury released to the aqueous environment is subject to biomethylation - conversion to the extremely toxic methyl mercury.

Mercury can be introduced into the body through the skin and the respiratory system as the elemental vapor. Mercuric salts are highly toxic to humans and can be absorbed through the gastrointestinal tract. Fatal doses can vary from 1 to 30 grams. Chronic toxicity of methyl mercury is evidenced primarily by neurological symptoms. Some mercuric salts cause death by kidney failure.

Mercuric salts are extremely toxic to fish and other aquatic life. Mercuric chloride is more lethal than copper, hexavalent chromium, zinc, nickel, and lead towards fish and aquatic life. In the food cycle, algae containing mercury up to 100 times the concentration in the surrounding sea water are eaten by fish which further concentrate the mercury. Predators that eat the fish in turn concentrate the mercury even further.

For the protection of human health from the toxic properties of mercury ingested through water and through contaminated aquatic organisms the ambient water criterion is determined to be 0.00014 mg/l.

124. Nickel. Nickel is seldom found in nature as the pure elemental metal. It is a relatively plentiful element and is widely distributed throughout the earth's crust. It occurs in marine organisms and is found in the oceans. The chief commercial ores

for nickel are pentlandite [$(Fe,Ni)_9S_8$], and a lateritic ore consisting of hydrated nickel-iron-magnesium silicate.

Nickel has many and varied uses. It is used in alloys and as the pure metal. Nickel salts are used for electroplating baths.

The toxicity of nickel to man is thought to be very low, and systemic poisoning of human beings by nickel or nickel salts is almost unknown. In non-human mammals nickel acts to inhibit insulin release, depress growth, and reduce cholesterol. A high incidence of cancer of the lung and nose has been reported in humans engaged in the refining of nickel.

Nickel salts can kill fish at very low concentrations. However, nickel has been found to be less toxic to some fish than copper, zinc, and iron. Nickel is present in coastal and open ocean water at concentrations in the range of 0.0001 to 0.006 mg/l although the most common values are 0.002 to 0.003 mg/l. Marine animals contain up to 0.4 mg/l and marine plants contain up to 3 mg/l. Higher nickel concentrations have been reported to cause reduction in photosynthetic activity of the giant kelp. A low concentration was found to kill oyster eggs.

For the protection of human health based on the toxic properties of nickel ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.0134 mg/l. If contaminated aquatic organisms are consumed, excluding consumption of water, the ambient water criterion is determined to be 0.100 mg/l. Available data show that adverse effects on aquatic life occur for total recoverable nickel concentrations as low as 0.0071 mg/l as a 24-hour average.

125. Selenium. Selenium (chemical symbol Se) is a non-metallic element existing in several allotropic forms. Gray selenium, which has a metallic appearance, is the stable form at ordinary temperatures and melts at 220°C. Selenium is a major component of 38 minerals and a minor component of 37 others found in various parts of the world. Most selenium is obtained as a by-product of precious metals recovery from electrolytic copper refinery slimes. U.S. annual production at one time reached one million pounds.

Principal uses of selenium are in semi-conductors, pigments, decoloring of glass, zerography, and metallurgy. It also is used to produce ruby glass used in signal lights. Several selenium compounds are important oxidizing agents in the synthesis of organic chemicals and drug products.

While results of some studies suggest that selenium may be an essential element in human nutrition, the toxic effects of selenium in humans are well established. Lassitude, loss of hair, discoloration and loss of fingernails are symptoms of selenium poisoning. In a fatal case of ingestion of a larger dose of selenium acid, peripheral vascular collapse, pulmonary edema, and coma occurred. Selenium produces mutagenic and teratogenic effects, but it has not been established as exhibiting carcinogenic activity.

For the protection of human health from the toxic properties of selenium ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.010 mg/l, i.e., the same as the drinking water standard. Available data show that adverse effects on aquatic life occur at concentrations higher than that cited for human toxicity.

128. Zinc. Zinc occurs abundantly in the earth's crust, concentrated in ores. It is readily refined into the pure, stable, silver-white metal. In addition to its use in alloys, zinc is used as a protective coating on steel. It is applied by hot dipping (i.e., dipping the steel in molten zinc) or by electroplating.

Zinc can have an adverse effect on man and animals at high concentrations. Zinc at concentrations in excess of 5 mg/l causes an undesirable taste which persists through conventional treatment. For the prevention of adverse effects due to these organoleptic properties of zinc, 5 mg/l was adopted for the ambient water criterion. Available data show that adverse effects on aquatic life occur at concentrations as low as 0.047 mg/l as a 24-hour average.

Toxic concentrations of zinc compounds cause adverse changes in the morphology and physiology of fish. Lethal concentrations in the range of 0.1 mg/l have been reported. Acutely toxic concentrations induce cellular breakdown of the gills, and possibly the clogging of the gills with mucous. Chronically toxic concentrations of zinc compounds cause general enfeeblement and widespread histological changes to many organs, but not to gills. Abnormal swimming behavior has been reported at 0.04 mg/l. Growth and maturation are retarded by zinc. It has been observed that the effects of zinc poisoning may not become apparent immediately, so that fish removed from zinc-contaminated water may die as long as 48 hours after removal.

In general, salmonoids are most sensitive to elemental zinc in soft water; the rainbow trout is the most sensitive in hard waters. A complex relationship exists between zinc concentration, dissolved zinc concentration, pH, temperature, and calcium and magnesium concentration. Prediction of harmful effects has been less than reliable and controlled studies have not been extensively documented.

The major concern with zinc compounds in marine waters is not with acute lethal effects, but rather with the long-term sublethal effects of the metallic compounds and complexes. Zinc accumulates in some marine species, and marine animals contain zinc in the range of 6 to 1,500 mg/kg. From the point of view of acute lethal effects, invertebrate marine animals seem to be the most sensitive organism tested.

MASS OF POLLUTANTS

In Section VI, the pollutant concentrations in the PM&F wastewater were presented by PM&F subcategories. Of equal importance is the mass of pollutants in the wastewater. The pollutant masses generated per year are estimated in this section for the pollutants in PM&F wastewater and are presented by subcategory.

The estimated pollutant masses were calculated by multiplying the following for each pollutant:

1. average subcategory production per year per process;
2. estimated number of wet processes;
3. average subcategory raw waste value (kg pollutant/ kg plastic material processed), and
4. pollutant detection fraction.

Average Subcategory Production Rate

The average subcategory production rate per process was based on the results of the questionnaire data base. The production rates for the direct and indirect discharge processes were listed by subcategory and summed. The average subcategory production rate was calculated by dividing the total production rate for the direct and indirect discharge processes by the number of direct and indirect discharge processes. For the contact cooling and heating water subcategory, the average production rate was 4,232 kkg of plastic material processed per year per process and for the cleaning and finishing water subcategory, the average production rate was 1,522 kkg of plastic material processed per year per process.

Estimated Number of Wet Processes

The number of wet processes was estimated in Section VI. There are 1,607 direct and indirect processes that use process water in the contact cooling and heating water subcategory; 667 are direct dischargers and 855 are indirect dischargers. In the cleaning and finishing water subcategory, there are 384 direct and indirect dischargers that use process water; 122 are direct dischargers and 262 are indirect dischargers. The zero dischargers were not used in estimating the pollutant masses because a zero discharger does not discharge wastewater.

Subcategory Average Raw Waste Values

The sampling data obtained from the sampling episodes for this project were used to calculate the subcategory average raw waste values for the pollutants in PM&F wastewater. The subcategory average raw waste value is the mass of pollutant discharged per kkg of plastic material processed.

A subcategory average raw waste value was calculated using the following:

1. a daily process raw waste value;
2. an average process raw waste value; and
3. an overall average raw waste value of all processes in the subcategory.

The daily process raw waste value is the product of the pollutant concentration (kg/l) found in samples collected during the sample episodes for this project and the production normalized flow for the sampled process. The production normalized flow is the liters of wastewater discharged per kkg of plastic material processed by the process on the sampling day. The daily process raw waste value is the mass of pollutant per kkg of plastic material processed (kg pollutant/kkg plastic). If the process was sampled on more than one day, the daily process raw waste values were summed and divided by the number of values to obtain the average process raw waste value. Pollutant concentrations above the source water concentrations and above the test method analytical detection limit were used in the average process raw waste concentration calculations.

The subcategory average raw waste value for a pollutant was obtained by adding the average process raw waste values for a subcategory and dividing that sum by the number of average process raw waste values. This calculation procedure is presented in Table VII-6.

The subcategory average raw waste values for the pollutants in PM&F wastewater are presented in Table VII-7.

Table VII-6

EXAMPLE CALCULATION OF A SUBCATEGORY AVERAGE RAW WASTE VALUE POLLUTANT X

Process	Day	Pollutant Concentration (kg/l)	Production Normalized Flow $\left(\frac{\text{liter Water}}{\text{kkg Plastic}}\right)$	Daily Process* Raw Waste Value $\left(\frac{\text{kg Pollutant}}{\text{kkg Plastic}}\right)$	Day	Pollutant Concentration (kg/l)	Production Normalized Flow $\left(\frac{\text{liter Water}}{\text{kkg Plastic}}\right)$	Daily Process* Raw Waste Value $\left(\frac{\text{kg Pollutant}}{\text{kkg Plastic}}\right)$	Average Process Raw** Waste Value $\left(\frac{\text{kg Pollutant}}{\text{kkg Plastic}}\right)$
A	1	3×10^{-6}	10,000	0.03	2	6×10^{-6}	9,000	0.054	0.042
B	1	15×10^{-6}	5,000	0.075	-	---	---	---	0.075
C	1	5×10^{-6}	8,000	0.04	2	1×10^{-6}	4,000	0.004	0.022

*Multiply the pollutant concentration by the production normalized flow to calculate the daily process raw waste value.

**Average the daily raw waste values from a process to calculate the average process raw waste value.

The subcategory average raw waste value for the pollutant is the average of the average process raw waste values of processes A, B, and C:

$$\text{Subcategory Average Raw Waste Value} = (0.042 + 0.075 + 0.022)/3 = 0.046 \ \frac{\text{kg Pollutant}}{\text{kkg Plastic}}$$

Table VII-7

ESTIMATED POLLUTANT MASS IN PROCESS WATER (CONTACT COOLING AND HEATING WATER SUBCATEGORY)

Average Subcategory Production - 4,232 kkg plastic/yr/process
Estimated Number of Direct and Indirect Processes - 1,522

Conventional Pollutants	Detection Fraction*	Subcategory Average Raw Waste Value kg Pollutant/kkg Plastic	Estimated** Pollutant Mass (kg/yr)
BOD_5	0.714	3.910	18,000,000
Oil and Grease	0.556	0.450	1,610,000
TSS	0.667	0.156	670,000
TOTAL			20,280,000
Nonconventional Pollutants			
COD	0.778	8.798	44,100,000
TOC	1.0	2.690	17,300,000
Total Phenols	0.444	0.185	529,000
TOTAL			61,929,000
Priority Pollutants			
4. benzene	0.444	3.490×10^{-3}	9,980
6. carbon tetrachloride	0.222	9.600×10^{-2}	137,000
11. 1,1,1-trichloroethane	0.556	3.950×10^{-3}	14,100
22. parachlorometa cresol	0.222	3.214×10^{-3}	4,600
23. chloroform	0.333	5.109×10^{-3}	11,000
44. methylene chloride (dichloromethane)	0.889	2.260×10^{-3}	12,900
65. phenol	0.556	1.026×10^{-3}	3,670
66. bis(2-ethylhexyl) phthalate	0.889	1.200×10^{-2}	68,700
68. di-n-butyl phthalate	1.0	4.560×10^{-4}	2,940
85. tetrachloroethylene	0.333	5.927×10^{-6}	13
86. toluene	0.444	8.347×10^{-5}	239
89. aldrin	0.333	1.58×10^{-5}	34
90. dieldrin	0.333	4.555×10^{-6}	10
93. 4,4'-DDE	0.222	2.312×10^{-7}	0.3
100. heptachlor	0.222	1.644×10^{-5}	24

Table VII-7 (Continued)

ESTIMATED POLLUTANT MASS IN PROCESS WATER
(CONTACT COOLING AND HEATING WATER SUBCATEGORY)

Average Subcategory Production - 4,232 kkg plastic/yr/process
Estimated Number of Direct and Indirect Processes - 1,522

Conventional Pollutants	Detection Fraction*	Subcategory Average Raw Waste Value kg Pollutant / kkg Plastic	Estimated** Pollutant Mass (kg/yr)
102. α-BHC	0.778	1.306×10^{-5}	65
103. β-BHC	0.333	2.911×10^{-6}	6
104. γ-BHC	0.556	1.753×10^{-6}	6
105. δ-BHC	0.556	7.964×10^{-6}	29
118. cadmium	0.333	1.772×10^{-4}	380
119. chromium	0.556	2.796×10^{-4}	1,000
120. copper	0.333	2.364×10^{-4}	507
122. lead	0.333	2.501×10^{-3}	5,360
123. mercury	0.111	1.750×10^{-7}	0.1
124. nickel	0.333	4.519×10^{-4}	969
128. zinc	0.667	1.856×10^{-3}	7,970
TOTAL			281,502.4

*Number of plants where pollutant concentration was greater than the concentration of the pollutant in the source water divided by the number of sampled plants.

**Pollutant mass = (average subcategory production) x (estimated number of processes) x (detection fraction) x (average raw waste value).

Table VII-7 (Continued)

ESTIMATED POLLUTANT MASS IN PROCESS WATER (CLEANING AND FINISHING WATER SUBCATEGORY)

Average Subcategory Production - 1,607 kkg plastic/yr/process
Estimated Number of Direct and Indirect Processes - 384

Conventional Pollutants	Detection Fraction*	Subcategory Average Raw Waste Value kg Pollutant / kkg Plastic	Estimated** Pollutant Mass (kg/yr)
BOD_5	0.833	1.815	933,000
Oil and Grease	0.429	0.409	108,000
TSS	0.857	2.230	1,180,000
TOTAL			2,221,000
Nonconventional Pollutants			
COD	0.857	2.836	1,500,000
TOC	1.0	2.100	1,300,000
Total Phenols	0.714	0.306	135,000
TOTAL			2,935,000
Priority Pollutants			
4. benzene	0.857	4.203×10^{-6}	2
23. chloroform	0.286	3.963×10^{-4}	70
44. methylene chloride (dichloromethane)	1.0	1.537×10^{-3}	948
62. N-nitrosodiphenylamine	0.714	1.055×10^{-4}	46
65. phenol	0.714	5.149×10^{-4}	227
66. bis(2-ethylhexyl) phthalate	0.857	7.402×10^{-5}	39
86. toluene	0.571	1.751×10^{-5}	6
89. aldrin	0.333	3.035×10^{-6}	0.6
100. heptachlor	0.333	5.118×10^{-7}	0.1
102. α-BHC	0.222	4.569×10^{-8}	0.006
104. γ-BHC	0.556	2.083×10^{-6}	0.7
105. δ-BHC	0.444	3.270×10^{-6}	0.9
119. chromium	0.714	2.818×10^{-4}	124
120. copper	0.571	5.691×10^{-4}	201
124. nickel	0.286	5.356×10^{-4}	95

Table VII-7 (Continued)

ESTIMATED POLLUTANT MASS IN PROCESS WATER (CLEANING AND FINISHING WATER SUBCATEGORY)

Average Subcategory Production - 1,607 kkg plastic/yr/process
Estimated Number of Direct and Indirect Processes - 384

Conventional Pollutants	Detection Fraction*	Subcategory Average Raw Waste Value kg Pollutant / kkg Plastic	Estimated** Pollutant Mass (kg/yr)
125. selenium	0.142	3.317×10^{-5}	3
128. zinc	1.0	1.657×10^{-3}	1,023
TOTAL			2,786.306

*Number of plants where pollutant concentration was greater than the concentration of the pollutant in the source water divided by the number of sampled plants.

**Pollutant mass = (average subcategory production) x (estimated number of processes) x (detection fraction) x (average raw waste value).

Pollutant Detection Fraction

The pollutant detection fraction was calculated by counting the number of plants where a pollutant was detected during the sampling episodes and dividing that sum by the total number of plants sampled. Only plants with pollutant concentrations above the concentrations in the source water were used to calculate this fraction. Pollutant detection fractions are listed in Table VII-7.

Estimated Pollutant Masses in Process Water by Subcategory

To calculate the estimated pollutant generated mass per year, the average subcategory production rate, the estimated number of wet processes, the pollutant subcategory average raw waste value, and the pollutant detection fraction were multiplied. Table VII-7 contains the estimated annual pollutant masses per PM&F subcategory for the pollutants in PM&F wastewater. These masses are for the number of direct and indirect dischargers in a subcategory.

SECTION VIII

TREATMENT TECHNOLOGY AND FLOW REDUCTION OPTIONS

Treatment technologies that can be used to control pollutants in wastewater generated by plants in the plastics molding and forming (PM&F) category are discussed in this section. These treatment technologies are divided into two types: in-plant control technologies and end-of-pipe treatment technologies. The primary literature sources relied upon during the development of this section were EPA's Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants and Innovative and Alternative Technology Assessment Manual. Metcalf and Eddy, Inc.'s Wastewater Engineering, Treatment/Disposal/Reuse served as a general reference and provided supporting information.

IN-PLANT TECHNOLOGY

The purpose of in-plant technology for plants in the plastics molding and forming category is to reduce or eliminate the amount of wastewater requiring end-of-pipe treatment and thereby reduce the existing wastewater treatment technology or eliminate the need for the treatment technology. In-plant technologies considered for the PM&F category are: (1) 100 percent recycle; (2) recycle with a discharge from the recycle unit; and (3) PM&F process modifications.

Process Water Recycle

Recycling of process water is the practice of recirculating water to be used again for the same purpose. Recycle is an important water conservation measure because the demand for raw water is reduced when process water is recycled. By reducing the amount of flow discharged the size and therefore the cost of any end-of-pipe treatment technology is also reduced. Treatment system performance may also be improved when recycle systems are used because pollutants are concentrated in the wastewater. Usually end-of-pipe treatment systems perform more effectively with higher pollutant concentrations.

One Hundred Percent Recycle Units. Process water that requires cooling is recycled through a unit that lowers the temperature of the water so that it can be reused. Two types of equipment are used for 100 percent recycle of the cooling water. The first and simplest piece of equipment is a holding tank. Cooling water is held up in a tank until the temperature drops sufficiently, through passive heat transfer to the environment, to allow the water to be recycled. A holding tank is only practical for low flow rates because tank sizes increase dramatically when the flow rate increases. Cooling water can also be recycled 100 percent

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through chillers that cool the water by mechanical refrigeration.
In a chiller, the cooling water is passed through a heat
exchanger that is cooled by a low boiling, vaporized refrigerant.
Chillers can be used with processes with medium flow rates
because they can be purchased as self-contained units that are
easy to install. Their use has been demonstrated in the PM&F
category, predominantly at flow rates between 20 and 50 gpm. At
higher flow rates, the chiller's high energy usage per unit of
cooling makes its use less attractive. One hundred percent
recycle systems such as cooling tanks or chiller units are
generally cleaned out once every one or two years.

Recycle Units with a Discharge. Cooling water can also be
recycled through cooling towers that lower water temperatures by
evaporative cooling. In a typical cooling tower configuration,
water is distributed at the top of the tower in a manner that
provides a large contact area between air and water. Air circu-
lates countercurrently to the water to be cooled. Heat is trans-
ferred from the water to the air as water evaporates. A cross
section of a typical cooling tower is presented in Figure VIII-1.
Cooling towers can be used with processes with flows from as low
as 15 gpm to several hundred gpm.

Total recycle through cooling towers is prohibited because of the
concentration of dissolved solids in process waters. Dissolved
solids are introduced into the cooling tower system in the water
that replaces the water lost by evaporation. A bleed stream is
needed to reduce the concentration of these dissolved solids
below the concentration where they would precipitate and cause
pipe plugging, and scaling on the cooling equipment.

Process water that requires the removal of solids and oil and
grease before it can be recycled can be recycled through a sedi-
mentation tank. Sedimentation is a process that removes solid
particles from a liquid matrix by gravitational force. This is
done by reducing the velocity of the influent flow so that gravi-
tational settling of solids can occur. The settled solids are
collected at the bottom of the tank as sludge. A sedimentation
tank can be designed so that oil and grease separation also
occur. Oil and grease and other floatable materials can be
removed from the sedimentation tank by surface skimming. Gener-
ally, process water that requires removal of suspended solids and
oil and grease has to be replaced after a period of time. This
can be done by replacing a small continuous discharge flow with
fresh water or periodically changing all of the processes within
the recycle unit.

Technology Status. Process water recycle is currently practiced
by 42 percent of wet processes in the contact cooling and heating
water subcategory and 13 percent of the wet processes in the

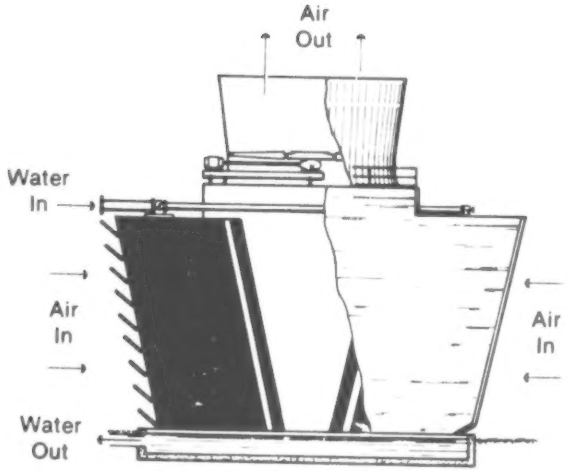


Figure VIII-1

CROSSFLOW COOLING TOWER

Adapted from Cooling Tower Fundamentals, The Marley Cooling Tower Company.

cleaning and finishing water subcategory. When recycle is used, the recycle percentage generally ranges from 90 to 100 percent. Table VIII-1 contains a distribution of the number of processes using various recycle percentages by PM&F subcategory based on data from the questionnaire data base.

Limitations. A potential problem with the recycle of contact cooling and heating water through a cooling tower is the buildup of dissolved solids which could result in scaling. Scaling can usually be controlled by depressing the pH and increasing the bleed flow. Recycling cleaning and finishing water requires the installation of a settling tank to remove suspended solids and floating oil and grease. Depending on the application, recycled cleaning and finishing water may be batch dumped periodically.

Reliability. The recycle of process water has been demonstrated at plants in the PM&F category and is also widely used by other industries. The basis of the technology, heat transfer for contact cooling and heating water and gravity settling for cleaning and finishing water is well established. Both systems have few components with moving parts; most of the routine maintenance is needed to service the recirculating pump.

Environmental Impact. Settled solids removed from sedimentation units are generally disposed of by a contract hauler. Small quantities of scale and settled solids may also be periodically removed from cooling towers, tanks and chillers. Evaporative water loss from cooling towers may be a problem in arid regions.

PM&F Process Modification

Two opportunities exist for plants to reduce the quantity of water used by PM&F processes. One is to decrease the quantity of water that flows through the process, the other is to modify the process so that the use of process water is no longer necessary.

The Agency believes that based on observations made during plant visits some plants may not pay close attention to water use. Satisfactory operation may be achieved with smaller rinse or contact cooling water flows. The practice of shutting off process water during periods when a production unit is inoperative and adjusting flow rates during periods of low activity can reduce the volume of water to be treated or discharged. Producers with a high water use should be able to reduce their water use through simple flow reduction procedures such as more careful adjustment of process water flow rates and reduction of overflow and dragout from quench tanks.

Since approximately 80 percent of the processes in the PM&F category do not require the use of process water, the possibility of

Table VIII-1

RECYCLE PERCENTAGES BY SUBCATEGORY

	Number of Processes in Questionnaire Data Base With Recycle (Percent of Subcategory)			
Percent Recycle	Contact Cooling and Heating Water Subcategory		Cleaning and Finishing Water Subcategory	
100	89	(19.8)	2	(2.1)
95 - 99.9	56	(12.5)	6	(6.4)
90 - 94.7	15	(3.3)	2	(2.1)
75 - 89.9	16	(3.6)	1	(1.1)
50 - 74.9	9	(2.0)	1	(1.1)
0.1 - 49.9	5	(1.1)	0	
0	258	(57.7)	82	(87.2)
TOTAL	448	(100)	94	(100)

eliminating the use of process water by the other 20 percent that use process water was studied. Investigation into the specific uses of process water revealed that the 20 percent of manufacturers who are using process water need that water for efficient and effective operation of their processes. The majority of PM&F process water is contact cooling water used during extrusion processes. This water is necessary for effective heat transfer, particularly during pelletizing processes and for the extrusion of tube, pipe, profiles, or plastic coverings on wire and cable. Process water is also needed for contact cooling during other molding and forming process to maintain product integrity. It is also used to clean and finish plastic products and to clean shaping equipment used to produce those products. Water is required in cleaning and finishing processes as a carrier media. Process water is required for certain PM&F processes, those processes cannot be converted to dry processes. Therefore, process modification to eliminate the use of process water is not applicable for those processes.

END-OF-PIPE TREATMENT TECHNOLOGY

End-of-pipe treatment technologies are treatment technologies used to reduce the levels of pollutants in wastewater. Pollutants or pollutant properties that were found at significant concentrations in PM&F wastewaters are presented in Table VIII-2.

End-of-pipe treatment technologies that will treat some, or all, of the above pollutants include: activated sludge, fixed growth biological treatment systems, package aerobic treatment units, sedimentation, gravity oil separation, neutralization, carbon adsorption, granular media filtration, and septic tanks followed by adsorption beds.

Activated Sludge

The activated sludge treatment process is used to remove dissolved and colloidal biodegradable organic pollutants from wastewater. It is a continuous flow, biological treatment process characterized by a suspension of aerobic microorganisms maintained in a relatively homogeneous state by the mixing and turbulence induced by aeration. Figure VIII-2 contains a flow diagram of a conventional activated sludge process. The microorganisms oxidize soluble and colloidal organic pollutants to carbon dioxide and water in the presence of molecular oxygen. The mixture of microorganisms and wastewater (called mixed liquor) formed in the aeration basin is transferred to a gravity sedimentation unit for liquid solids separation. A large portion of the microorganisms that settle in the clarifier is recycled to the aeration basin to be mixed with incoming wastewater; the remainder of the microorganisms is transferred to sludge handling processes. Microorganism solids not settled are lost in the effluent.

Table VIII-2

POLLUTANTS AND POLLUTANT PROPERTIES FOUND IN SIGNIFICANT CONCENTRATIONS IN PM&F WASTEWATER

Conventional Pollutants

BOD_5
Oil and Grease
TSS
pH

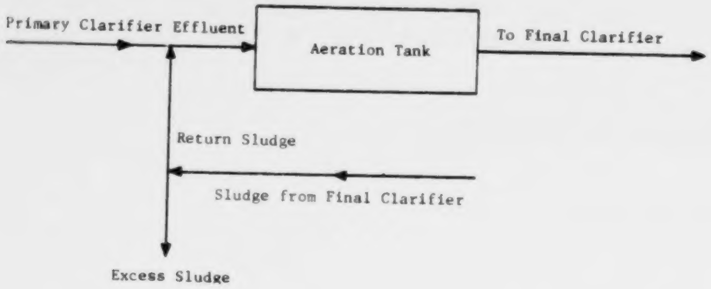
Nonconventional Pollutants

COD
TOC
Total Phenols

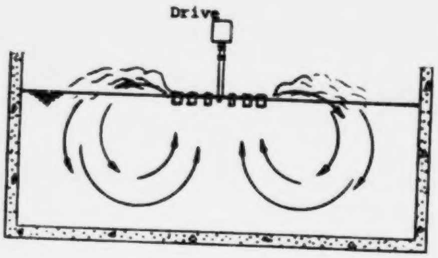
Priority Pollutants

4. benzene
6. carbon tetrachloride (tetrachloromethane)
11. 1,1,1-trichlorethane
22. parachlorometa cresol
23. chloroform (trichloromethane)
44. methylene chloride (dichloromethane)
62. N-nitrosodiphenylamine
65. phenol
66. bis(2-ethylhexyl) phthalate
68. di-n-butyl phthalate
85. tetrachloroethylene
86. toluene
89. aldrin
90. dieldrin
93. 4,4'-DDE (p,p'DDX)
100. heptachlor
102. α-BHC
103. β-BHC
104. γ-BHC
105. δ-BHC
118. cadmium
119. chromium (Total)
120. copper
122. lead
123. mercury
124. nickel
125. selenium
128. zinc

Flow Diagram, Conventional Activated Sludge Process



Mechanical Surface Aeration



Diffused Aeration (Sparger)

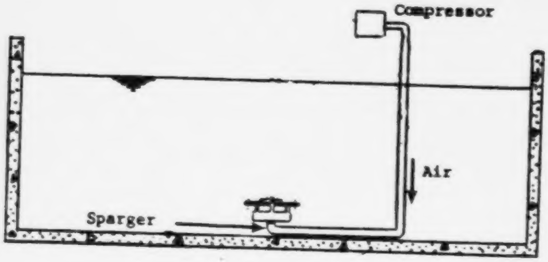


Figure VIII-2

ACTIVATED SLUDGE TREATMENT TECHNOLOGY

Figures adapted from Innovative and Alternative Technology Assessment Manual, EPA 430/9-78-009.

During the oxidation process, organic material is synthesized into new cells, some of which undergo auto-oxidation (self-oxidation or endogenous respiration) in the aeration basins; the remainder form a net increase of microorganisms in the mixed liquor or excess sludge. Oxygen is required in this process to support the oxidation and synthesis reactions.

Various aeration methods are employed to transfer oxygen to wastewater. They include: diffused aeration, mechanical aeration, and pure oxygen.

Diffused Aeration. In a diffused air system compressors are used to supply air to a diffusion network. Diffused air systems may be classified as fine bubble or coarse bubble. Diffusers commonly used in the activated sludge process include porous ceramic plates laid in the basin bottom (fine bubble), porous ceramic domes or ceramic or plastic tubes connected to a pipe header and lateral system (fine bubble), tubes covered with synthetic fabric or wound filaments (fine or coarse bubble), and specifically designed spargers with multiple openings (coarse bubble). A diffused aeration sparger system is depicted in Figure VIII-2.

Mechanical Aeration. Mechanical aeration methods include a submerged turbine with compressed air spargers (agitator/sparger system) and surface mechanical entrainment aerators. The agitator/sparger system consists of a radial-flow turbine located below the mid-depth of the basin with compressed air supplied to the turbine through a sparger. The surface-type aerators entrain atmospheric air by producing a region of intense turbulence at the water surface. They are designed to pump large quantities of liquid, thus dispersing the entrained air and agitating and mixing the basin contents. Figure VIII-2 also contains a schematic diagram of a mechanical surface aeration unit.

Pure Oxygen. The use of pure oxygen for activated sludge treatment has become competitive with the use of air due to the development of efficient oxygen dissolution systems. The main benefits of substituting pure oxygen for air include reduced power requirements for dissolving oxygen in the wastewater, reduced aeration tank volume, and improved biokinetics of the activated sludge. Lower amounts of excess sludge are generated and the activated sludge thickening capability is generally greater than the thickening capability of the air activated sludge process.

Applications. The activated sludge process is employed in domestic and industrial wastewater treatment for the removal of conventional, nonconventional, and priority pollutants. Limited metals removal has also been observed through activated sludge systems. Activated sludge processes can be used to treat PM&F wastewater to remove the pollutants found in significant concentrations (see Table VIII-2). Industrial wastewater that is amenable to biological treatment and degradation may be jointly treated with domestic wastewater in a conventional activated sludge process.

Limitations. Activated sludge treatment processes can be upset with variations in hydraulic and organic loadings. For example, shock loadings of phenolic compounds will kill the microorganisms that oxidize the organic materials and make the activated sludge process work. Under steady state conditions, phenols can be treated in concentrations up to 500 mg/l (Metcalf & Eddy, Inc.). Activated sludge processes are not designed for an intermittent wastewater flow. Other disadvantages are high operating costs, operational complexity, and energy consumption. The activated sludge process must be well maintained for it to work properly.

Reliability. Activated sludge has not been demonstrated for the treatment of wastewater generated solely by PM&F processes. However, it is a widely demonstrated, effective biological treatment process that has been used to treat wastewaters with similar characteristics to PM&F wastewater. In particular, it is used to treat wastewater generated by processes in the organic chemicals, plastics, and synthetic fibers category.

Environmental Impact. The activated sludge process requires proper disposal of sludge to avoid solid waste pollution problems. Excess sludge suspended solids generation is generally in the range of 0.15 to 0.7 pound per pound BOD removed (EPA Treatability Manual). Energy requirements are approximately 200 kwh/yr per 1,000 gpd treated (Innovative and Alternative Technology Assessment Manual). Improperly operated systems can cause odor problems.

Treatability Data. Treatability data for activated sludge process systems treating PM&F wastewater are not available; however, treatability data for activated sludge processes for conventional pollutants are available from several studies of other industrial categories. The available treatability data that are most applicable to the PM&F category are data from the organic chemicals, plastics, and synthetic fibers category because wastewaters generated by procceses in each category are similar with respect to conventional pollutants. Those data are presented in Table VIII-3. A statistical analysis comparing raw wastewater generated by proccesses in the PM&F category to wastewater generated by processes in the organic chemicals, plastics, and synthetic fibers category, particularly the plastics only subcategory, is presented in Appendix D. Performance data for the activated sludge process for selected nonconventional and priority pollutants are presented in Table VIII-4. The sources of these data are indicated on the table.

Table VIII-3

EFFLUENT CONCENTRATION VALUES FOR ACTIVATED SLUDGE PROCESS TRANSFERRED FROM THE ORGANIC CHEMICALS, PLASTICS AND SYNTHETIC FIBERS CATEGORY*

Pollutant Parameter	One Day Maximum Effluent Concentration (mg/l)	Maximum 30-Day Average Effluent Concentration (mg/l)
BOD_5	49	22
Oil and Grease	71	17
TSS	117	36

*See Appendix D.

Table VIII-4

REMOVAL EFFICIENCIES FOR NONCONVENTIONAL POLLUTANTS AND TREATABILITY LIMITS FOR PRIORITY POLLUTANTS FOR ACTIVATED SLUDGE PROCESSES

Nonconventional Pollutant	Mean Effluent Concentration (mg/l)	Mean Removal Efficiency %
COD	890	63
TOC	427	63
Total Phenols	18.7	60

Priority Pollutants		Treatability Limit (mg/l)
4.	benzene	0.005
11.	1,1,1-trichloroethane	0.005
23.	chloroform (trichloromethane)	0.005
44.	methylene chloride (dichloromethane)	0.005
62.	N-nitrosodiphenylamine	0.005
66.	bis(2-ethylhexyl) phthalate	0.200
68.	di-n-butyl phthalate	0.005
86.	toluene	0.005
104.	γ-BHC	0.005

Sources:

Nonconventional Pollutants: USEPA, Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, July 1980, EPA-600/8-80-042c.

Priority Pollutants: USEPA, Contractors Engineering Report, Analysis of Organic Chemicals and Plastics and Synthetic Fibers Industries Toxic Pollutants, November 16, 1981, Contract No. 68-01-6024.

Fixed Growth Biological Treatment Systems

Fixed growth biological treatment processes bring wastewater to be treated in contact with media covered by microbiological growth. Either the wastewater is passed over the media or the media is passed through the wastewater. Organic material in the wastewater is oxidized by the microbiological growth. The two most common forms of fixed growth biological treatment systems are trickling filters and rotating biological contactors.

Trickling Filters. A trickling filter consists of a fixed bed of rock or plastic media over which wastewater is applied for aerobic biological treatment. Zoogleal slimes form on the mixed media and assimilate and oxidize biodegradable material in the wastewater. The bed is dosed by a distributor system; treated wastewater is collected by an underdrain system. Primary treatment is normally required to optimize trickling filter performance. If filter effluent is recycled through the filter, the filter is known as a high rate trickling filter. If no recycle is used the filter is designated a low rate trickling filter.

Rotating Biological Contactors. Rotating biological contactors (RBC) use a fixed-film biological reactor consisting of plastic media mounted on a horizontal shaft and placed in a tank. Common media forms are a disc-type made of styrofoam and a denser lattice-type made of polyethylene. While wastewater flows through the tank the media are slowly rotated about 40 percent immersed. The media contact the wastewater and the organic pollutants are oxidized by the biological film that develops on the media. Rotation results in exposure of the film to the atmosphere where aeration occurs. Excess biomass on the media is stripped off by rotational shear forces and the stripped solids are maintained in suspension by the mixing action of the rotating media. Suspended solids settle in the sedimentation unit following the RBC. Multiple staging of RBCs increases treatment efficiency and aids in achieving nitrification.

Applications. Fixed growth biological processes can be used to treat domestic and industrial wastewaters amenable to aerobic biological treatment.

Technology Status. The trickling filter process is in widespread use in older treatment plants. The process is highly dependable in moderate climates; they are less effective in colder climates. The RBC process has been in use in the United State only since 1969 and is not yet in widespread use. Use of the process is growing, however, because of its characteristic modular construction, low hydraulic head loss, and shallow excavation, which makes it adaptable to new or existing treatment facilities.

Limitations. Fixed growth biological treatment systems are vulnerable to climatic changes and low temperatures. Recycle of water through trickling filters may be restricted during cold weather because after the first pass through the filter the water may be too cold for re-application to the filter. Rotating biological contactors are often housed or covered to protect them from low temperatures. Trickling filters are susceptable to filter fly and odor problems and require long recovery times after upsets. High organic loadings in RBCs can result in septicity and supplemental aeration may be required.

Reliability. Fixed media biological treatment processes perform reliably if wastewater characteristics do not vary and if installation is in a climate where wastewater temperatures do not fall below 55°F for prolonged periods.

Environmental Impact. Odors can result if septic conditions develop in the process. Filter flies can also grow in trickling filters; these flys may transmit disease.

Treatability Data. Mean removal efficiencies for certain conventional, nonconventional, and priority pollutants for trickling filters are presented in Table VIII-5. Mean removal efficiences for certain conventional and nonconventional pollutants for RBCs are presented in Table VIII-6. The sources of these data are referenced on the tables.

Package Aerobic Treatment Units

There are two types of package aerobic treatment units commercially available today. These are: (1) suspended growth units and (2) fixed growth units. Each unit has its own unique operational characteristics and design features, but both provide oxygen transfer to the wastewater and intimate contact between microbes and the oxygenated wastewater. The microorganisms oxidize soluble and colloidal organics to carbon dioxide and water. Biomass is also formed during the oxidation step and is removed from the effluent in a solids separation step.

Suspended Growth Systems - Extended Aeration. Extended aeration is a modification of the activated sludge process whereby a high concentration of microorganisms are maintained in an aeration tank followed by separation of the biomass and recycle of all or a portion of the biomass back to the aeration tank. There are a variety of proprietary extended aeration package plants available on the market today. A typical design features three chambers. The influent enters the first chamber where scum and sludge are separated. The second chamber is where the aeration occurs. The third and final compartment is a settling chamber where sludge settles by gravity and is returned to the aeration portion of the unit. Figure VIII-3 presents a diagram of an extended aeration unit.

Table VIII-5

TRICKLING FILTER PERFORMANCE DATA FOR CERTAIN CONVENTIONAL, NONCONVENTIONAL, AND PRIORITY POLLUTANTS

Conventional Pollutants	Influent Concentration (mg/l)	Effluent Concentration (mg/l)	Percent Removal	Reference*
TSS	120	49	59	1
BOD_5	390	39	90	1
Nonconventional Pollutants				
COD	807	541	33	1
Priority Pollutants				
23. chloroform	---	0.019	0	1
44. methylene chloride	---	0.001	0	1
55. naphthalene	---	0.005	0	1
65. phenol	0.105	0.009	91	2
		0.037	0	1
	400	288-308	23-28	1
	25	1	96	1
	31	<1.0	>97	1
66. bis(2-ethylhexyl) phthalate	0.035	0.006	83	1
70. diethyl phthalate	---	0.140	0	1

Dashes indicate that data were not available.

*1 - Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, July 1980, EPA-600/8-80-042C.

2 - Vela, G. R. and J. R. Ralston, Canadian Journal of Microbiology, 1366 (1978).

Table VIII-6

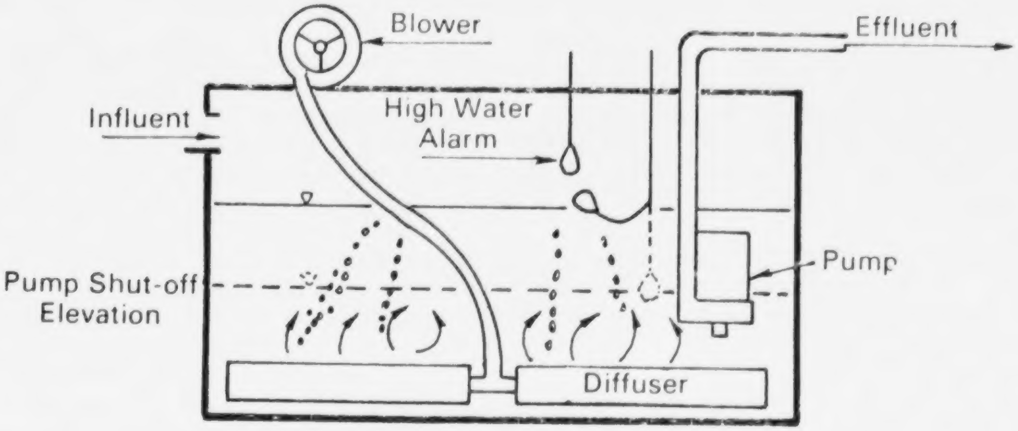
REMOVAL EFFICIENCIES FOR CERTAIN CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS FOR ROTATING BIOLOGICAL CONTACTORS*

Pollutant Parameter	Mean Effluent Concentration (mg/l)	Mean Removal Efficiency (%)
BOD_5	31	74
TSS	54	8
Oil and Grease	28	9
COD	710	41

*Treatability data are not available for the priority pollutants.

Source: Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, July 1980, EPA-600/8-80-042c (July 1980).

Batch - Extended Aeration



Flow-Through Extended Aeration

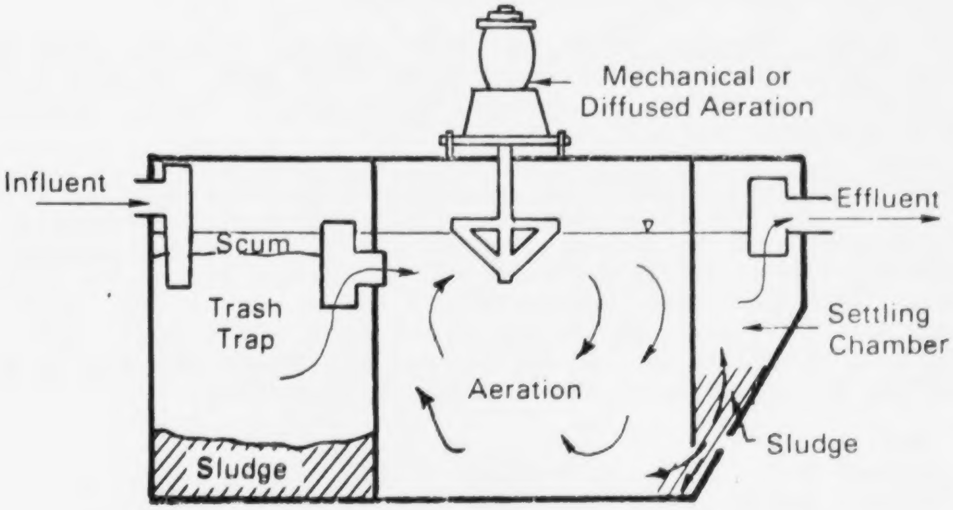


Figure VIII-3

EXAMPLES OF EXTENDED AERATION PACKAGE PLANTS

Fixed Growth Systems. Fixed growth package plants employ the same technology as large scale trickling filters and RBCs described in the previous section. Figure VIII-4 presents various fixed growth package plant configurations.

Applications. There are no physical site conditions that limit application. Package aerobic units can be used whenever biological treatment of wastewater is appropriate. Package aerobic units can be used to treat PM&F wastewater to remove the pollutants found at significant concentrations (see Table VIII-2). Fixed growth units should be housed when used in cold climates.

Technology Status. Package aerobic treatment plants are available in several configurations from various manufacturers. They have been used effectively in both domestic and industrial applications.

Limitations. Package aerobic units are susceptible to upsets. Without regular supervision and maintenance the aerobic unit may produce low-quality effluents. The biological treatment process is temperature-dependent; package aerobic treatment units may need to be insulated as climate dictates.

Reliability. Package aerobic treatment plants, particularly the associated blowers and pumps, require regular supervision and maintenance to insure optimum operation.

Environmental Impacts. The aeration systems require power and some noise and odor may be associated with them. Sludge produced by these plants has to be removed periodically (e.g., once every 8 to 12 months).

Treatability Data. Performance data for package aerobic treatment units are available from National Sanitation Foundation studies conducted on domestic sewage. These studies showed a mean BOD_5 removal efficiency of 90 percent on raw waste with a 171 mg/l BOD_5 influent concentration and a mean TSS removal efficiency of 90 percent on raw waste with a 232 mg/l TSS influent concentration. These values are based on data from the following NSF Wastewater Performance Evaluations:

Report S40-1	October 1982
Report S40-5	April 1974
Report S40-6	April 1974
Report S40-7	August 1979
Report S40-8	June 1979
Report S40-9	August 1979
Report S40-10	November 1981
Report S40-11	May 1982

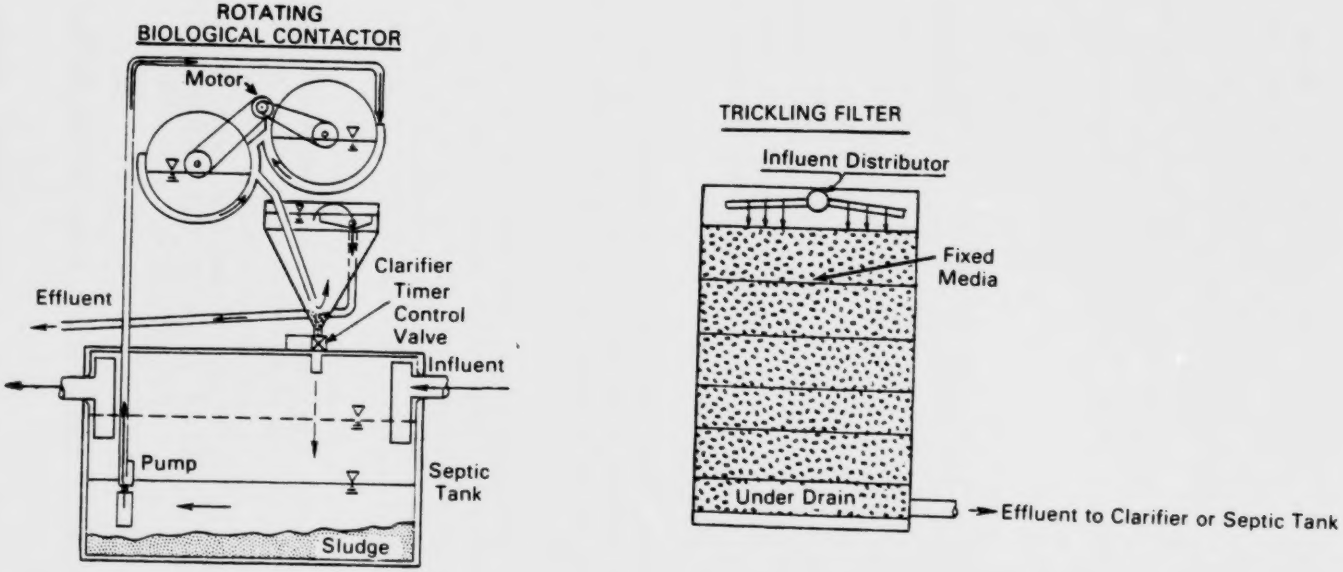


Figure VIII-4

EXAMPLES OF FIXED GROWTH PACKAGE PLANTS

Package aerobic treatment plants are generally subject to the same applications and constraints as the larger scale units that employ the same technology. Extended aeration is actually a small scale activated sludge treatment process and the fixed growth package plants are similar to either larger scale trickling filters or rotating biological contactors, depending on the technology employed. Therefore, package plants have generally the same treatment effectiveness as larger systems employing the same technology.

Sedimentation

Sedimentation is a process that removes solid particles from a liquid matrix by gravitational force. This is done by reducing the velocity of the influent flow so that gravitation settling can occur. Simple sedimentation requires long retention times to achieve high removal efficiencies. Sedimentation tanks are designed with baffles to eliminate the turbulance caused by influent water and have sloping bottoms to aid in sludge collection. Sedimentation tanks are often designed so that gravity oil separation occurs. Oil and grease and other floatable materials can be removed by surface skimming.

Applications. Sedimentation can be effectively used to treat wastewater with high concentrations of oil and grease and suspended solids. Toxic metals removal has also been demonstrated in sedimentation tanks.

Technology Status. Sedimentation has been effectively demonstrated in the treatment of numerous industrial wastewaters. It is one of the oldest wastewater treatment technologies in use. Twelve plants in the questionnaire data base for the PM&F category have sedimentation/clarification units in place to treat PM&F wastewater.

Limitations. Excessively long retention times may be required under certain conditions, particularly when the specific gravity of suspended particles is close to one or the particle sizes are small. Colloidal particles with diameters less than one micron may not be effectively settled without the addition of a flocculant or coagulating agent. Additionally, dissolved pollutants are not removed by sedimentation.

Reliability. The lack of mechanical complexity makes this technology very reliable.

Environmental Impact. The major environmental impact associated with sedimentation is the disposal of the solid material removed from the wastewater.

Treatability Data. Mean removal efficiencies for certain conventional, nonconventional, and priority pollutants in sedimentation tanks are presented in Table VIII-7.

Gravity Oil Separation

Gravity oil separation removes floatable oil and grease. A gravity oil separator (skimming tank) is a chamber arranged so that floating matter rises and remains on the surface of the wastewater until removed, while the liquid flows out continuously through deep outlets or under partitions, curtain walls, or deep scum boards. Oil and grease separation may be accomplished in a separate tank or combined with primary sedimentation, depending on the process and nature of the wastewater.

The objective of skimming tanks is to separate lighter floating substances from wastewater. The material collected on the surface of skimming tanks, whence it can be removed, includes oil, grease, soap, and floating solid material. A gravity oil separator is depicted in Figure VIII-5.

Gravity separators are the most common devices employed in oily waste treatment. The effectiveness of a gravity separator depends on proper hydraulic design and wastewater retention times. Longer retention times allow better separation of the floatable oils from the water. Short detention times of less than 20 minutes result in less than 50 percent oil-water separation, while more extended holding periods improve oil separation. Gravity separators are equally effective in removing both greases and nonemulsified oils. Separators may be operated as batch vats or as continuous flow-through basins depending on the volume of wastewater to be treated.

Applications. Used in most industrial wastewater treatment systems where floatable oil is present.

Technology Status. Gravity oil separation is well-developed for many industrial wastewater treatment applications. Four plants in the PM&F category questionnaire data base use oil skimming technology to treat PM&F wastewater.

Limitations. Gravity oil separation has no limitations. It is a simple operation that can be used to remove floatable oil and grease when present in wastewater.

Reliability. Highly dependable, if regularly maintained. Variable wastewater characteristics such as flow, temperature, and pH can adversely affect performance.

Environmental Impact. If skimmings cannot be reclaimed they are typically disposed of as solid waste.

Table VIII-7

REMOVAL EFFICIENCIES FOR CERTAIN CONVENTIONAL, NONCONVENTIONAL, AND PRIORITY POLLUTANTS IN SEDIMENTATION TANKS

Pollutant Parameter	Mean Effluent Concentration (mg/l)	Mean Removal Efficiency %
BOD_5	2,500	33
Oil and Grease	70	47
TSS	212	82
COD	1,620	71
TOC	63	40
Total Phenols	6.3	43
119. chromium	2.9	76
120. copper	0.072	66
128. zinc	2.1	65

Source: Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, July 1980, EPA 600/8-80-042c.

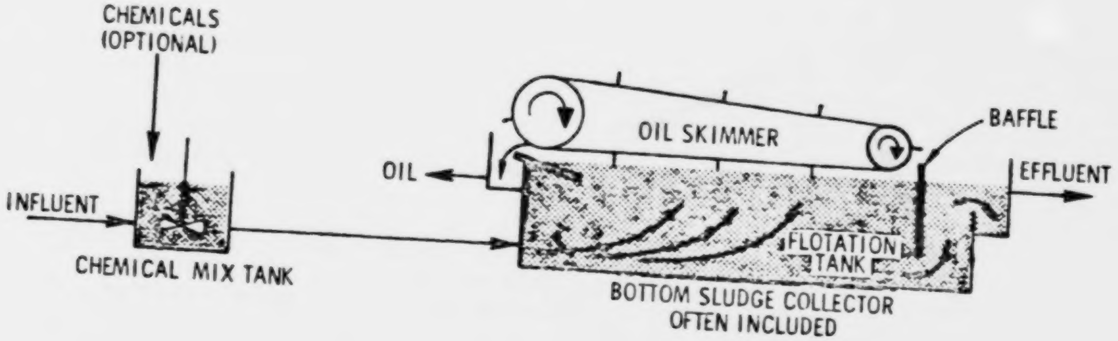


Figure VIII-5

GRAVITY OIL SEPARATOR

Treatability Data. Gravity oil separation is an effective method of removing insoluble oil and grease from PM&F wastewater. The removal of oil and grease lowers the levels of COD and TOC in wastewater samples. An additional benefit of gravity oil separation is the reduction of concentrations of any priority pollutants that are more soluble in oil than in water.

Neutralization

Neutralization is the process of adjusting an acidic or a basic wastewater to a pH of an acceptable value. Neutralization of an acidic or basic wastewater is necessary for various reasons. The pH should be adjusted to: (1) prevent metal corrosion and/or damage to equipment and structures; (2) protect aquatic life and human welfare; (3) assure effective operation of a treatment process; and (4) provide neutral pH water for recycle. pH adjustment may also be needed to break emulsions, to insolubilize certain chemical species, or to control chemical reaction rates (e.g., chlorination). Generally, the pH of a wastewater should be between 6.0 and 9.0.

The actual process of neutralization is accomplished by the addition of a basic material to an acidic material or by adding an acid to an alkaline material. Addition of the neutralization agent must be carefully controlled to avoid large temperature increases due to the exothermic nature of most acid-base neutralization reactions. Neutralization chemicals can be added manually or automatically to a mixed tank. Continuous pH monitoring is usually included in an automatic system.

Carbon Adsorption

Activated carbon removes pollutants from water by the process of adsorption (i.e., the attraction and accumulation of one substance on the surface of another). Activated carbon preferentially adsorbs organic compounds over other compounds and, because of this selectivity, is effective in removing organic pollutants from wastewater. This sorption process occurs when wastewater is passed over the activated carbon in a packed bed.

The term activated carbon applies to any amorphous form of carbon specially treated to give high adsorption capacities. The adsorption of materials onto the active sites in the activated carbon is a reversible process, allowing the carbon to be regenerated for reuse using either heat and steam or solvents.

Carbon adsorption requires preliminary treatment of the wastewater to remove excess suspended solids, oils, and greases. Suspended solids in the influent should be less than 50 mg/l to minimize backwash requirements; oil and grease should be less than 10 mg/l.

Activated carbon was considered as a preliminary option for the control of pollutants in PM&F wastewater. However, activated carbon treatment is a sophisticated and expensive control technology that is most effectively used to remove non-polar, high molecular weight organic chemicals from wastewater. This technology has specialized applications and the design parameters of a system are highly site specific. For this reason the Agency does not believe that the activated carbon technology is feasible for the plastics molding and forming category. This technology was not considered further.

Granular Media Filtration

Granular media filtration, one of the oldest and most widely applied types of filtration for the removal of suspended solids uses a bed of granular particles (typically sand with coal) as the filter media. The bed is usually contained within a basin or tank and is supported by an underdrain system that allows filtered liquid to be drawn off while retaining the filter media in place. As wastewater passes through the media, solid material is trapped on top of and within the bed. This reduces the porous nature of the bed, which either reduces the filtration rate at a constant pressure or increases pressure needed to force the wastewater through the filter. If left to continue in this manner, the filter eventually plugs with solids; therefore, the solids must be removed. This is done by forcing wash water through the bed of granular particles in the reverse direction of the wastewater flow. Wash water is pumped through the bed at a velocity sufficiently high so that the filter bed becomes fluidized and turbulent. In this turbulent condition, the solids are dislodged from the granular particles and are discharged in the spent wash water. When this backwashing cycle is completed, the filter is returned to service. A diagram of a granular media filter in filtration and backwashing modes is presented in Figure VIII-6.

Granular media filtration is an effective and widely used method for removing total suspended solids from wastewater. Mean removal efficiencies ranging from 10 to 25 percent for oil and grease, BOD, TOC, COD, and total phenols have also been achieved in granular medial filtration systems. (Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, EPA 600/8-80-042c.)

Granular media filtration was initially considered as a possible PM&F wastewater treatment technology but was not considered when the technology options were selected. Suspended solid levels in contact cooling and heating water are not high enough to warrant granular media filtration, while average cleaning and finishing water suspended solids concentrations indicate that the filter

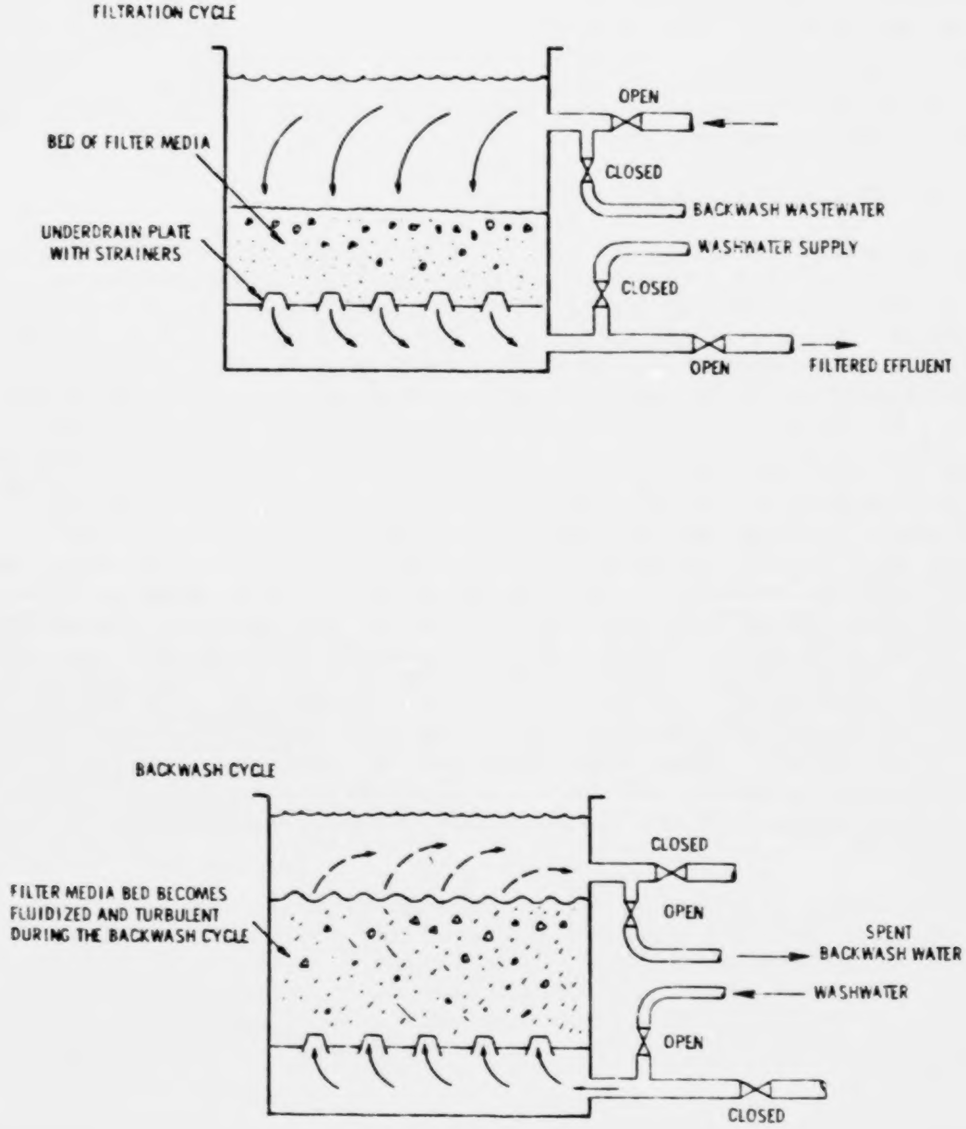


Figure VIII-6

GRANULAR MEDIA FILTRATION PROCESS

would be frequently plugged and require excessive backwashing. Therefore, this technology was not considered feasible.

Septic Tank-Soil Absorption Bed

A septic tank followed by a soil absorption bed is a traditional onsite system for the treatment and disposal of wastewater from individual households or establishments. The system consists of a buried tank where wastewater is collected and a subsurface drainage system where clarified effluent percolates into the soil. Solids are collected and stored in the tank, forming sludge and scum layers. Anaerobic digestion occurs in these layers, reducing their overall volume. Effluent is discharged from the tank to one of three basic types of subsurface systems: absorption trenches, seepage beds, or seepage pits. Sizes of the subsurface system are usually determined by site percolation rates, soil characteristics, and site size and location. Pipes are laid in the subsurface system to distribute the wastewater over the absorption area.

Septic tank-soil absorption beds were initially considered as a possible PM&F wastewater treatment technology, but were not used to develop the technology options. Since these systems are dependent on soil and site conditions (e.g., the ability of the soil to absorb liquid and depth to groundwater) the Agency does not believe these systems are feasible as the basis for the PM&F effluent limitations guidelines and standards.

Contract Haul

Instead of being discharged by the plants in the PM&F category, wastewater could be stored and then removed from the plant site by a contract hauler. The feasibility of this method of disposal depends on the plant wastewater production rate. Wastewater production rates at many of the plants in the PM&F category are low enough, especially when the possibility of additional process water reduction and recycle is considered, to make contract hauling a disposal method. There is currently limited use of contract hauling of process wastewater in the PM&F category. Two cleaning and finishing processes in the questionnaire data base dispose of process water by contract hauling. One process produces a finishing wastewater from a polishing step. This wastewater is disposed of in a landfill as a solid waste. The other wastewater is generated in a detergent washing process that is removed by a contract hauler. Contract haul of process wastewater was considered further for the technology options for the PM&F category.

SECTION IX

COSTS, ENERGY, AND NON-WATER QUALITY ASPECTS

This section presents estimated costs of the wastewater treatment and control technologies described in Section VIII. These cost estimates, together with the estimated pollutant reduction performance for each treatment and control option presented in Section X, provide a basis to evaluate the treatment and control technology options and to identify the best practicable technology currently available (BPT), best available technology economically achievable (BAT), best conventional pollutant control technology (BCT), best demonstrated technology (BDT), and the appropriate technology for pretreatment. The cost estimates are also used as the basis to estimate the economic impact of the proposed effluent limitations guidelines and standards on the plastics molding and forming category. In addition, this section addresses non-water quality environmental impacts of the wastewater treatment and control options, including energy requirements, air pollution, and solid wastes.

BPT TREATMENT TECHNOLOGY OPTIONS

Costs were developed for BPT Options 2 and 3 for the contact cooling and heating water subcategory and for BPT Options 1, 2, and 3 for the cleaning and finishing water subcategory. Costs were not developed for BPT Option 1 for the contact cooling and heating water subcategory because Option 1 provides no pollutant removal benefits and thus was rejected as a possible treatment option. Below are brief descriptions of the BPT treatment options for which costs were developed. These are the same treatment options considered for BAT, BCT, and NSPS.

Contact Cooling and Heating Water Subcategory

Option 2:

For processes with an average process water flow rate of 15 gpm or less - Zero discharge by 100 percent recycle of process water using either a tank or a chiller.

For processes with an average process water usage flow rate greater than 15 gpm - Recycle through a cooling tower and treatment of the recycle unit discharge in a package activated sludge plant. An equalization tank is included as part of the package plant.

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Option 3:

For processes with an average process water usage flow rate of 15 gpm or less - Zero discharge by 100 percent recycle of the wastewater through either a tank or a chiller.

For processes with an average process water usage flow rate greater than 15 gpm - Recycle through a cooling tower and zero discharge by contract haul of the discharge from the recycle unit.

The flow cut-off for BPT Options 2 and 3 for costing purposes differs from the flow cut-off for the BPT options presented in Section X of this document. The original cut-off for the treatment options presented in Section X was 15 gpm and treatment costs were developed based on that cut-off. The cut-off was subsequently changed to 35 gpm to reflect the average flow rate of the best processes that recycle 100 percent of the process water using a chiller. The Agency believes that the results of the cost analyses based on the 15 gpm cut-off support the proposed BPT 35 gpm cut-off because technology costs for processes with flow rates between 15 and 35 gpm are expected to decrease and benefits for these processes are expected to increase (i.e., more processes will achieve zero discharge of pollutants by recycling 100 percent of the process water) when the 35 gpm cut-off is used. The Agency will revise these analyses using the 35 gpm cut-off prior to promulgation of the PM&F effluent limitations guidelines.

Cleaning and Finishing Water Subcategory

Option 1:

pH adjustment and sedimentation.

Option 2:

For processes with an average process water usage flow rate of two gpm or less - Recycle through a sedimentation tank and contract haul of the discharge from the recycle unit.

For processes with an average process water usage flow rate greater than two gpm - Recycle through a sedimentation tank and treatment of the discharge from the recycle unit in a package activated sludge plant. The treatment system also includes an equalization unit and pH adjustment.

Costs used to evaluate Option 2 are based on recycle and contract hauling for processes with an average process water usage flow rate of two gpm or less because the Agency assumes that plants will comply with the proposed regulation in the least costly manner. Equipment vendors indicate that the smallest commercially available package activated sludge plant is designed for a flow rate of 600 gallons per day. Assuming a minimum recycle ratio of 70 percent for the flow reduction unit in the BPT model treatment technology for this option, a process must have an average process water usage flow of greater than two gpm for the package activated plant to function properly. Although EPA recognizes that plants with cleaning and finishing processes with a flow rate of two gpm or less may choose to install a custom built system to achieve the limitations, it is difficult for EPA to estimate the costs of a custom system. Further, the Agency believes that for plants with an average process water usage flow rate of two gpm or less, it may be more economical to contract haul the wastewater. Thus, the Agency costed contract hauling for plants with an average water process flow rate of two gpm or less for this option.

Option 3:

Recycle through a sedimentation tank for all processes and contract haul of the discharge from the recycle unit.

Costs of Treatment Technology Options for BAT, BCT, and NSPS

Additional costs have not been developed for treatment options considered for BAT, BCT, and NSPS because the options considered for BAT, BCT, and NSPS are the same as the options considered for BPT. Therefore, the costs of these options are the same as the costs of the BPT options.

Treatment costs for new sources are assumed to be the same as the treatment costs for existing sources with similar size. This is a conservative assumption. Costs could be lower for new sources because new production processes can be designed to reduce the amount of wastewater discharged. Therefore, for those new sources there would be no costs associated with retrofitting a plant or process within the plant.

No costs were developed for the technology basis for pretreatment standards because, as discussed in Section XIII of this document, the Agency proposes not to establish pretreatment standards for either subcategory.

COST ESTIMATES

Sources of Cost Data

Capital and operation and maintenance (O&M) cost data for the treatment technologies were obtained from two sources: (1) equipment manufacturers, and (2) the literature. The major sources of capital costs were contacts with equipment vendors.

Most of the O&M cost information was obtained from the literature.

Cost Components

Capital Costs. Capital costs consist of equipment costs and system costs. Equipment costs include: (1) the purchase price of the manufactured equipment and any accessories; (2) delivery charges, which account for the cost of shipping the purchased equipment a distance of 500 miles; and (3) installation charges, which includes charges for labor, excavation, site work, and materials.

System costs include engineering, administrative, and legal costs, contingencies, and the contractor's fee. The engineering, administrative, and legal costs are expressed as a percentage of the equipment costs. Contingencies and contractor's fee are expressed as a percentage of the sum of the equipment costs and the engineering, administrative, and legal costs. Equipment costs and system costs are added to obtain the capital costs. The components of capital costs are:

Item No.	Item	Cost
1	Equipment Costs	Cost of installed equipment
2	Engineering, Administration, and Legal	10% of Item 1
3	Subtotal	Item 1 and Item 2
4	Contingency	15% of Item 3
5	Contractor's Fee	10% of Item 3
6	Total Capital Costs	Items 3 through 5

Operation and Maintenance Costs. Operation and maintenance (O&M) costs for the technology options include the following:

- Raw materials costs - These costs are for chemicals used in the treatment processes, which include such things as caustic, sulfuric acid, corrosion inhibitors, and biocides.
- Operation labor and materials costs - These costs account for the labor and materials directly associated with operation of the process equipment. Labor requirements

are estimated in terms of hours per year. A composite labor rate of 21 dollars per hour was used to convert the hour requirements to an annual cost. This composite labor rate includes a base labor rate of nine dollars per hour for skilled labor, 15 percent of the base labor rate for supervision, and plant overhead at 100 percent of the base rate plus supervision. Nine dollars per hour is the Bureau of Labor national wage rate for skilled labor.

- Maintenance and repair costs - These costs account for the labor and materials required for repair and routine maintenance of the equipment. Maintenance and repair costs were assumed to be five percent of the equipment costs based on information from literature sources unless more reliable data could be obtained from vendors.
- Energy cost - Energy or power costs were calculated based on total nominal horsepower requirements (in kw-hrs); an electricity charge of \$0.049/kilowatt-hour; and an operating schedule of 24 hours/day, 250 days/year unless specified otherwise. The electricity charge rate (March 1982) is based on the industrial cost derived from the Department of Energy's Monthly Energy Review.

Cost Update Factors. All costs have been standardized by adjusting them to the first quarter of 1982. The cost indices used for particular components of costs are described below.

Capital Costs - Capital costs were adjusted using the EPA-Sewage Treatment Plant Construction Cost Index. The value of this index for March 1982 is 414.0.

Operation and Maintenance-Labor Costs - The Engineering News-Record Skilled Labor Wage Index was used to adjust the portion of operation and maintenance cost attributable to labor. The March 1982 value is 325.0.

Maintenance and Materials Costs - The producer price index published by the Department of Labor, Bureau of Statistics was used. The March 1982 value of this index is 276.5.

Chemical Costs - The Chemical Engineering Producer Price Index for industrial chemicals was used. This index is published biweekly in Chemical Engineering magazine. The March 1982 value of this index is 362.6.

Cost Estimates

To estimate capital and O&M costs for the treatment technologies, cost data from all sources were plotted on a graph of capital or O&M costs versus a design parameter (usually flow). These data were usually distributed over a range of flows. Cost data for unit process equipment gathered from the various sources included costs for equipment with a variety of auxiliary components, basic construction materials cost, and costs based on different points of origin for the equipment. A single line was fitted to the data points thus arriving at a cost curve that represented an average of all the costs for a unit process. Since the cost estimates presented in this section must be applicable to treatment technologies used in varying circumstances and geographic locations, the Agency believes this approach is best to estimate the costs of the technology options for this project. For consistency in estimating costs and accuracy in reading the final cost curves, equations were developed to represent the final cost curves. Capital and operation and maintenance cost equations are listed in Table IX-1.

The cost estimates developed for the treatment of PM&F wastewater are based on the segregation of wastewater. Costs have been developed for separate recycle systems for cooling and heating water and cleaning and finishing water. On the questionnaire process flow diagrams returned by plants in the PM&F category, segregation of contact and non-contact cooling water was found to be a general industry practice. Therefore, contact cooling water was assumed to be segregated from non-contact cooling water when treatment costs were developed.

TECHNOLOGY COSTS

Recycle Unit - Contact Cooling and Heating Water Subcategory

Equipment used to recycle contact cooling and heating water includes a recirculating pump, a heat transfer unit (e.g., a tank, a cooling tower, or a chiller), a cold water holding tank, and necessary piping and electrical accessories, including instrumentation. The capital costs for the recycle unit includes installation costs and delivery costs.

Quench Tank Technology

The Agency assumed that separate tanks are not needed for cooling for low flow rate processes (i.e., one tank to quench or cool the plastic product and one tank to cool the quench water). Instead, a single tank was costed for product cooling. This tank has enough surface area to allow the quench water to be cooled in the tank by heat loss to the environment. The design basis for the quench tank is:

- The volume of a quench tank needed for sufficient cooling is based on a tank surface area of 75 ft^2/gpm and a depth to length ratio of 0.25. The value of 75 ft^2/gpm is taken from Figure 12-25 in Perry and

Table IX-1

COST EQUATIONS FOR TREATMENT AND CONTROL TECHNOLOGIES

Equipment	**Equation**	**Range of Validity**
Agitators, C-clamp	$C = 417 + 4030\ (HP)$ $A = 104 + 351\ (HP)$	$0 < HP < 0.25$
	$C = 839.1 + 587.5\ (HP)$ $A = 2739.89 + 403.365\ (HP) + 0.7445\ (HP)^2$	$0.25 < HP < 0.33$
Agitators, Top Entry	$C = 1585.55 + 125.302\ (HP) - 3.27437\ (HP)^2$ $A = 2739.89 + 403.365\ (HP) + 0.7445\ (HP)^2$	$0.33 < HP < 5.0$
Caustic Feed System	$C = 2655.77 + 1231.21\ (F) - 40.3243\ (F)^2$	$0 < F < 12.5$
Chiller System	$C = 2131.34 + 1473.27\ (TR) - 11.9265\ (TR)^2$ $A = 1092.25 + 435.734\ (TR) - 0.413462\ (TR)^2$	$0.5 < TR < 7.5$
Contract Hauling	$C = 0$ $A = 0.40\ (G)(HPY)$	Non Hazardous Washes
Cooling Tower System	$C = \exp[8.76408 + 0.07048\ (\ln T) + 0.050949\ (\ln T)^2]$ $A = \exp[9.08702 - 0.75544\ (\ln T) + 0.140379\ (\ln T)^2]$	$1 < T < 700$
Package Activated Sludge Plant	$C = 2566$ $A = 910$	$X < 600$
	$C = 9165$ $A = 3055$	$600 < X < 1500$
	$C = 6500 + 1.71\ X$ $A = 1600 + 0.96\ X$	$1500 < X < 5000$
	$C = \exp[1.57977 + 1.22209\ (\ln X) - 0.028484(\ln X)^2]$ $A = 4538.99 + 0.0737513\ (X) - 2.77111 \times 10^{-7}\ (X^2)$	$5000 < X < 100{,}000$
Pumps, Centrifugal	$C = \exp[6.31076 + 0.228887\ (\ln Y) + 0.0206172\ (\ln Y)^2]$ $A = \exp[6.67588 + 0.031335\ (\ln Y) + 0.062016\ (\ln Y)^2]$	$3 < Y < 3500$
Tank, Fiberglass	$C = 3100.44 + 1.19041\ (V) - 1.7288 \times 10^{-5}\ (V)^2$ $A = 0$	$500 < V < 24{,}000$
Tank, Steel Equalization	$C = 14{,}759.8 + 0.170817\ (V) - 8.44271 \times 10^{-8}\ (V)^2$	$24{,}000 < V < 500{,}000$
	$C = 3{,}100.44 + 1.19041\ (V) - 1.7288 \times 10^{-5}\ (V)^2$	$1{,}000 < V < 24{,}000$
	$C = \exp[6.88763 - 0.643189\ (\ln V) + 0.11525\ (\ln V)^2]$	$V < 1{,}000$
	$A = 0$	

C - Direct capital, or equipment costs (1982 dollars)
A - Direct operation and maintenance costs (1982 dollars/year)
F - Chemical feed rate (pounds/hour)
HP - Power requirement (horsepower)
HPY - Plant operating hours (hours/year)
T - Cooling capacity in evaporative tons (°F gallons/minute)
TR - Cooling capacity in refrigerative tons
V - Tank capacity (gallons)
X - Wastewater flow rate (gallons/day)
Y - Wastewater flow rate (gallons/minute)

Chilton's Chemical Engineer's Handbook and is based on the following assumptions for ambient conditions and water temperatures:

Relative humidity	50 percent
Wind velocity	0 miles per hour
Dry bulb air temperature	75°F
Solar heat gain	0 Btu/hr·ft^2
T_{hot}	100°F
T_{cold}	85°F

T_{hot} refers to the quench tank effluent water temperature and T_{cold} refers to the quench tank influent water temperature.

Cost equations used to estimate capital costs for tanks are presented in Table IX-1. An additional 20 percent of the tank cost was added to the capital cost to allow for a unique application of a tank for product quenching operations. O&M costs are five percent of the capital cost.

Chiller Technology

A recirculating water chiller system includes the following equipment:

- Air cooled water chiller with recirculating pump and associated piping
- Cold water holding tank
- Associated piping and instrumentation

The design basis for a chiller is:

- The temperature change though the chiller system was assumed to be 10°F, from 60°F to 70°F, based on current industry practice.

- One ton of refrigeration can cool 2.4 gpm of water 10°F based on thermodynamic considerations, with a chiller efficiency of 80 percent.

- Water holding tank designed with a 0.5 hour retention time.

- 100 percent recycle.

Capital costs were obtained through vendor contacts. A capital cost equation based on information provided by vendors is presented in Table IX-1.

Chiller unit O&M costs include:

- Labor costs (50 hours/year)
- Utility costs for the pump and compressor
- Maintenance costs.

A chiller unit O&M cost equation is presented in Table IX-1.

Cooling Tower Technology

Cooling tower capital costs are based on a cooling tower that consists of the following:

- Cooling tower and accessories
- Piping or force main (1,000 feet)
- Holding/water storage tank
- Recirculating pump
- Chemical water treatment system

The design basis for the cooling tower is:

- A cooling tower size is based on the following parameters:

  Recycle ratio - 0.996
  Wet bulb temperature - 75°F
  T_{hot} - 95°F
  T_{cold} - 85°F

  The recycle ratio of 0.996 is assumed to be the maximum practicable recycle ratio in a cooling tower system using total dissolved solids concentration as the limiting factor. Vendors indicated that using average city makeup water, cooling tower water should be able to undergo three to four concentrations. This is equivalent to 99.6 percent recycle for a 10°F temperature range based on Figure 40 in Marley's Cooling Tower Fundamentals.

- 1,000 feet of carbon steel pipe with necessary valves and fittings for yard piping.
- Pump size based on the recirculation rate.
- A retention time of one hour for the water holding tank.

Based on the design assumptions, the tons of cooling necessary were determined from the definition of a standard evaporative ton. One standard evaporative ton is the power required to cool three gpm of water 10°F:

$$\text{Number of Evaporative Tons Needed} = \frac{\text{Recirculated Flow Rate (gpm)} \times \text{Range } (^\circ\text{F})}{\dfrac{3\ \text{gpm} \times 10^\circ\text{F}}{\text{Standard Evaporative Ton}}}$$

Because the assumed temperature range is 10°F, the number of evaporative tons needed is:

$$\text{Number of Evaporative Tons Needed} = \frac{\text{Recirculated Flow Rate (gpm)}}{3\ (\text{gpm/evaporative ton})}$$

Capital and O&M cost equations for a cooling tower and accessory equipment are presented in Table IX-1.

Cooling tower O&M costs include:

- Raw material cost for chemical water treatment (e.g., slime, pH, corrosion control) at $15/ton
- Operating labor costs (based on five hours/month)
- Utility costs for the fan
- Maintenance and repair costs (based on 55 hours of labor a year for cooling towers with less than 100 tons capacity and 1/6 hour per ton plus 33 hours for cooling towers greater than 100 tons capacity).

Recycle Unit - Cleaning and Finishing Water Subcategory

The recycle technology for the cleaning and finishing subcategory includes a sedimentation tank, a recirculating pump, and associated piping. The sedimentation tank is needed for the gravity separation of solids and for oil and grease removal.

The design basis for this recycle technology is:

- Four hour retention time for sedimentation tank.
- Pump size based on recycle ratio.
- Recycle ratio of 98.3 percent based on an assumption of total system blowdown every two weeks. Hours of operation were assumed to be five days per week, 24 hours per day. The recycle ratio of 98.3 percent reflects recycle rates currently achieved by processes in the cleaning and finishing water subcategory.

Tank and pump capital costs were calculated from the cost equations given in Table IX-1.

O&M costs include maintenance and utility costs for the pump. They were calculated using the pump cost equation presented in Table IX-1.

Sedimentation tank sludge removal costs were also estimated. Volume of sludge removed is based on 100 percent removal of suspended solids in the sedimentation tank (suspended solids were assumed to have a specific gravity of 1.0). Sludge removal cost is based on a contract hauling charge of $0.40 per gallon. The $0.40 per gallon rate is based on information from several sources, including a paint industry survey, comments from the aluminum forming industry, and the literature.

Equalization

Equalization equipment includes an equalization tank, an agitator, and a pump. The design basis for the equalization equipment is:

- Equalization tank volume is equal to the recycle sedimentation tank volume for the cleaning and finishing water subcategory or the recycle water holding tank volume for the contact cooling and heating water subcategory. This allows for complete recycle system blowdown without short circuiting the wastewater treatment unit. If a plant has more then one process, the equalization tank size is based the largest blowdown from the recycle system. That assumes that all recycle systems are not blown down at the same time.
- Agitator size based on 3×10^{-5} horsepower per gallon from theoretical energy requirement calculation and agitator efficiency of 80 percent.
- Pump size based on flow rate.

Equations used to estimate capital and O&M costs for the equalization tank, agitator, and pump are given in Table IX-1.

Package Activated Sludge Plant

Package activated sludge plants usually contain a primary sedimentation unit, an activated sludge unit, and a secondary sedimentation unit. The package activated sludge plant consists of three chambers. The influent enters the first chamber where scum and sludge are separated. The second chamber is where aeration occurs either by mechanical or diffused aeration. The final compartment is a sedimentation unit where sludge settles by gravity and is returned to the aeration unit.

Capital costs for package activated sludge plants were obtained through vendors. Costs include purchase costs of the equipment, delivery costs, site work costs, installation costs, and associated labor costs. A capital cost equation for a package activated sludge plant is presented in Table IX-1.

O&M costs were also obtained from vendors. O&M costs include utility costs, labor costs, maintenance costs, and cost associated with annual tank cleanout. An O&M cost equation for this technology is also presented in Table IX-1.

pH Adjustment

pH adjustment requires a pH probe and controller, caustic or acid feed system, a mix tank, and an agitator. The design basis for pH adjustment is:

- pH adjustment takes place in the equalization tank of a treatment technology if equalization is used.
- If equalization is not required, pH adjustment occurs in a 0.5 hour retention time mix tank with an appropriately sized agitator.
- pH adjustment is based on the adjustment of the pH from pH 5 to pH 6. An influent pH of 5 was chosen based on a review of pH's from the sampling data. The adjusted pH of 6 is the lower limit of the acceptable range of pH 6 to 9.

Capital costs for pH adjustment include $2,000 for a pH probe and controller and costs for a caustic feed system. Caustic feed system costs were assumed to be the same as costs for an alum feed system. A capital cost equation for the caustic feed system is presented in Table IX-1.

O&M costs include costs for 12 hours of labor per year, five percent of the capital cost per year for maintenance, and a price of $0.285 per pound of caustic. Energy requirements are negligible. Costs of an acid addition feed system are similar to costs of a caustic feed system. Costs were developed for the caustic feed system because PM&F wastewater generally has to be adjusted from acidic to neutral conditions if pH adjustment is necessary. This approach is conservative because an acid feed system requires a less sophisticated liquid metering system than a caustic feed system and the raw material costs are lower.

Sedimentation

Equipment associated with sedimentation includes a sedimentation tank and a pump and associated piping. The design basis for the sedimentation unit is:

- A four hour retention time sedimentation tank.

- Pump size based on flow rate.

Equations used to develop capital costs for pumps and tanks are given in Table IX-1. Piping cost was assumed to be 15 percent of the tank cost.

O&M costs for tanks and pumps were estimated using equations in Table IX-1. Annual sludge and scum removal charges were based on 82 percent removal of total suspended solids and 47 percent removal of oil and grease (see Section VIII). Removed pollutants were assumed to have a specific gravity of 1.0. Sludge and scum are removed from the sedimentation tank once per month by a contract hauler at a charge of $0.40 per gallon. The $0.40 per gallon rate is based on information from a paint industry survey, comments from the aluminum forming industry, and the literature. Minimum monthly charge for removal is $75.00, based on telephone conversations with sludge haulers.

CALCULATION OF INDIVIDUAL PLANT COSTS

To facilitate the calculation of individual plant costs, process water usage flow ranges were established and a range standardized flow was selected for each range. Capital and O&M costs for each regulatory option were calculated for each range standardized flow. For a treatment option, the capital and O&M costs were calculated by first determining the process water usage flow range for the process and then using the capital and O&M costs for the range standardized flow for that process as the capital and O&M costs for the treatment option.

The ranges and range standardized flows were chosen so that the technology costs for the range standardized flow reflect the average technology costs for processes with flows within a range. This was done by assigning the ranges and the range standardized flows so that the difference between the range standardized flow and the maximum or minimum flows within a range were proportional to the range standardized flow. The flow ranges and range standardized flows used are listed below:

Flow Range		Range Standardized Flow
$0 < X \le 0.3$ gpm	- costed at	0.15 gpm
$0.3 < X \le 2$ gpm	- costed at	1 gpm
$2 < X \le 8$ gpm	- costed at	5 gpm
$8 < X \le 20$ gpm	- costed at	15 gpm
$20 < X \le 50$ gpm	- costed at	35 gpm
$50 < X \le 100$ gpm	- costed at	75 gpm
$100 < X \le 200$ gpm	- costed at	150 gpm
$200 < X \le 300$ gpm	- costed at	250 gpm

Costs were developed individually for processes with an average process water usage flow rate above 300 gpm because the population of plants in that flow range was too small for the range-standardized flow approach.

Individual plant costs were calculated for each treatment technology option using the following methodology. If a plant had more than one process in a subcategory, the process water flow rates of each process were summed and the treatment technology costs for a process with a flow rate equal to the sum of the flow rates were considered as the plant costs. If the plant had one or more processes in both subcategories and proces water from both subcategories was not treated in a common end-of-pipe treatment system, the process water flow rates of processes in each subcategory were summed and treatment technology costs were determined for each subcategory based on a process with a flow rate equal to the sum of the flow rates. The sum of the subcategory treatment technology costs was considered as the plant costs. If a plant had one or more processes in each subcategory and process water from processes in both subcategories was treated in a common end-of-pipe treatment system, plant costs were based on the costs of a treatment system designed to treat the combined process water.

Estimated costs for BPT Options 2 and 3 for the contact cooling and heating water subcatagory are presented in Tables IX-2 and IX-3. Costs for BPT Options 1, 2, and 3 for the cleaning and finishing water subcategory subcategory are presented in Tables IX-4, IX-5, and IX-6, respectively.

Table IX-2

BPT OPTION 2 COSTS
CONTACT COOLING AND HEATING WATER SUBCATEGORY

Flow Range (gpm)	Equipment Costs	Total Capital Costs	Annual O&M Costs
$0 < X \leq 0.3$	$ 770	$ 1,060	$ 40
$0.3 < X \leq 2$	$ 4,140	$ 5,690	$ 1,310
$2 < X \leq 8$	$ 7,420	$ 10,200	$ 2,180
$8 < X \leq 20$	$15,380	$ 21,100	$ 4,340
$20 < X \leq 50$	$28,960	$ 39,800	$ 9,710
$50 < X \leq 100$	$38,180	$ 52,500	$10,930
$100 < X \leq 200$	$60,240	$ 82,800	$15,270
$200 < X \leq 300$	$76,240	$105,000	$18,050

Table IX-3

BPT OPTION 3 COSTS
CONTACT COOLING AND HEATING WATER SUBCATEGORY

Flow Range (gpm)	Equipment Costs	Total Capital Costs	Annual O&M Costs
$0 < X \leq 0.3$	$ 770	$ 1,060	$ 40
$0.3 < X \leq 2$	$ 4,140	$ 5,690	$ 1,310
$2 < X \leq 8$	$ 7,420	$10,200	$ 2,180
$8 < X \leq 20$	$15,380	$21,100	$ 4,340
$20 < X \leq 50$	$18,250	$25,100	$ 23,150
$50 < X \leq 100$	$24,570	$33,800	$ 51,030
$100 < X \leq 200$	$33,880	$46,600	$101,410
$200 < X \leq 300$	$44,740	$61,500	$187,200

Table IX-4

BPT OPTION 1 COSTS
CLEANING AND FINISHING WATER SUBCATEGORY

Flow Range (gpm)	Equipment Costs	Total Capital Costs	Annual O&M Costs
$0 < X \leq 0.3$	$ 6,340	$ 8,710	$ 1,780
$0.3 < X \leq 2$	$ 8,500	$11,700	$ 2,360
$2 < X \leq 8$	$11,800	$16,300	$ 2,440
$8 < X \leq 20$	$13,000	$17,900	$ 4,180
$20 < X \leq 50$	$24,800	$34,100	$ 7,250
$50 < X \leq 100$	$35,000	$48,200	$15,840
$100 < X \leq 200$	$40,700	$55,900	$38,600
$200 < X \leq 300$	$49,300	$67,800	$62,880

Table IX-5

BPT OPTION 2 COSTS
CLEANING AND FINISHING WATER SUBCATEGORY

Flow Range (gpm)	Equipment Costs	Total Capital Costs	Annual O&M Costs
$0 < X \le 0.3$	$ 800	$ 1,100	$ 535
$0.3 < X \le 2$	$ 2,960	$ 4,070	$ 3,040
$2 < X \le 8$	$ 20,850	$ 28,700	$ 7,130
$8 < X \le 20$	$ 27,250	$ 37,500	$ 9,270
$20 < X \le 50$	$ 38,420	$ 52,800	$12,830
$50 < X \le 100$	$ 63,650	$ 87,500	$25,640
$100 < X \le 200$	$109,800	$151,000	$57,200
$200 < X \le 300$	$156,400	$215,000	$89,170

Table IX-6

BPT OPTION 3 COSTS
CLEANING AND FINISHING WATER SUBCATEGORY

Flow Range (gpm)	Equipment Costs	Total Capital Costs	Annual O&M Costs
$0 < X \le 0.3$	$ 800	$ 1,100	$ 535
$0.3 < X \le 2$	$ 2,960	$ 4,070	$ 3,040
$2 < X \le 8$	$ 6,020	$ 8,280	$ 10,500
$8 < X \le 20$	$ 9,430	$13,000	$ 28,780
$20 < X \le 50$	$15,300	$21,000	$ 59,670
$50 < X \le 100$	$23,900	$32,900	$153,400
$100 < X \le 200$	$45,000	$61,900	$410,800
$200 < X \le 300$	$62,900	$86,500	$683,900

An example that illustrates how the BPT costs were calculated is presented in Table IX-7. The table presents costs for each piece of equipment necessary for BPT Option 2 for the contact cooling and heating water subcategory. These costs were calculated using the equations in Table IX-1.

Table IX-7

BPT OPTION 2 COSTS FOR THE RANGE STANDARDIZED FLOW OF 150 GPM, CONTACT COOLING AND HEATING WATER SUBCATEGORY

Equipment	Equipment Capital Costs	Annual O&M Cost
Cooling tower (55 tons)	$19,240	$ 4,080
Recirculating Pump (150 gpm)	2,140	4,430
Holding Tank (9,100 gal)	12,500	---
Equalization Tank (9,100 gal)	12,500	---
Agitator (0.34 hp)	1,630	2,880
Pump (1 gpm)	730	880
Package Aerobic Treatment Unit (860 gpd)	9,100	3,000
Piping	2,400	---
TOTAL	$60,240	$15,270

The total capital cost is the equipment costs plus 10 percent of the equipment costs for engineering, administrative, and legal. Twenty-five percent of the equipment costs plus engineering, administrative, and legal costs were added for contingency costs and contractor's fee:

60,240	Equipment Costs
+ 6,024	+ 10% (administrative, engineering and legal)
66,264	
+ 16,566	+ 25% (contingency and contractor's fee)
82,830	Total Capital Cost

An equipment cost credit for treatment in place was subtracted for any plants with recycle units currently in place. Credit for those systems was calculated in the following manner. If a process had a recycle unit with a recycle rate between 80 and 100 percent, the Agency assumed that the process could meet the regulatory flow allowance with no additional capital expenditure for a recycle unit. Thus, a credit equal to the full cost of a recycle unit was subtracted from the estimated cost.

If a process had a recycle unit with a recycle rate between 60 and 80 percent, the Agency estimated that a 30 percent increase in recycle capacity would be required for the plant to meet the regulatory flow allowance. The cost to retrofit a recycle unit for a 30 percent increase in recycle capacity was assumed to equal 60 percent of the cost of installing a new unit. Therefore, there is a 40 percent cost savings achieved by increasing the capacity of an existing recycle unit. A credit equivalent to 40 percent of the cost of a new recycle unit was subtracted from the technology cost for each process with between 60 and 80 percent recycle. If a process had below 60 percent recycle, no credit for treatment in place was allowed.

No treatment in place credits were allowed for annual costs because plants with treatment in place have to continue to operate their recycle units to meet the effluent limitations guidelines and standards in this proposed regulation.

ENERGY AND NON-WATER QUALITY IMPACTS

The following are the energy and non-water quality environmental impacts associated with the proposed regulation. EPA has determined that the impacts identified below are justified by the benefits associated with compliance with the proposed effluent limitations guidelines and standards.

Energy Requirements

The Agency estimates that the achievement of BPT effluent limitations guidelines will result in a net increase in electrical energy consumption of approximately 19.9 million kw-hr/yr, which is less than one percent of the estimated total current energy usage for the PM&F category. The net increase in electrical energy consumption was estimated by adding the energy requirements of the equipment required for BPT for each direct discharging plant in the questionnaire data base and then scaling-up the estimated value for the number of plants in the category. Total current energy usage for the PM&F category was projected from the energy usage information supplied by plants in the questionnaire survey.

Since the Agency is not proposing BAT or BCT effluent limitations guidelines more stringent than BPT, no additional electrical energy is required. There is no additional electrical energy consumption associated with pretreatment standards since the Agency is not proposing PSES and PSNS.

EPA believes that the energy used by a new direct discharging plant will be the same amount used by an existing source at BPT. Therefore, the estimated annual plant energy use for NSPS is the same as the annual average energy use for BPT, which is 14,000 kw-hr/yr. This does not significantly add to the total energy consumption for the PM&F category. The Agency concludes that the increased energy used to comply with these proposed effluent limitations guidelines and standards is insignificant and that effluent reduction benefits outweigh the increased energy use.

Air Pollution

Technologies used as the basis for the proposed effluent limitations guidelines and standards settle or biologically oxidize pollutants found in PM&F wastewater. Some volatile organic compounds (e.g., methylene chloride) may be emitted to the air from these treatment technologies. However, those emissions are not expected to cause air pollution problems. Accordingly, the proposed effluent limitations guidelines and standards will not create any substantial air pollution problems.

Solid Waste

EPA believes that only very small amounts of solid wastes are currently generated by PM&F plants because of the limited use of treatment technologies in the PM&F category. EPA estimates that the proposed BPT effluent limitations guidelines will increase the production of solid wastes by 42,000 metric tons (or kkg) per year beyond that generated by treatment in place. These wastes are comprised of settled solids that may contain toxic metals, treatment process sludges containing biological solids, skimmed oil, and residues from the periodic cleaning of the recycle equipment. This increase in solid waste generation was estimated by totaling the amount of solid waste that would be generated by each plant in the questionnaire data base if those plants used the model BPT treatment. This total was then scaled-up for the number of plants in the category. Solid wastes are generated in the sedimentation tanks of the recycle units for processes in the cleaning and finishing water subcategory and in the sedimentation units of the package activated sludge treatment plants. The proposed BAT and BCT effluent limitations guidelines result in no additional solid waste production because BAT and BCT are the same as BPT.

EPA believes that the amount of solid wastes generated by a new source will be the same as the amount generated by an existing source at BPT. Therefore, the estimated annual average plant production of solid wastes generated by compliance with NSPS is the same as the annual average plant production for BPT, which is 22 metric tons per year. No additional solid wastes will be generated by indirect dischargers because the Agency is not proposing categorical pretreatment standards.

The Agency examined the solid wastes that would be generated at PM&F plants by the proposed model treatment technologies and believes they are not hazardous under Section 3001 of the Resource Conservation and Recovery Act (RCRA). This judgment is based on the recommended treatment technology of recycle of wastewater treatment and discharge in a package activated sludge plant consisting of primary sedimentation, activated sludge, and final sedimentation.

None of the toxic organic compounds for which the extract in the Extraction Procedure (EP) toxicity test are analyzed are in PM&F process water (see 40 CFR 261.24 (45 FR 33084; May 19, 1980)). Only four of the eight metals for which the extracts from the EP toxicity test are analyzed were found in contact cooling and heating process water. Only two of those metals were found in cleaning and finishing process water. EPA believes that the estimated concentration of those metals in the treatment system sludge will not cause the concentration of those metals in the EP test extract to exceed the "allowable" concentration (i.e., the concentration that makes the wastes hazardous) in the extract.

PM&F wastes are also not listed as hazardous pursuant to 40 CFR Part 261.11 (45 FR 33121; May 19, 1980, as amended by 45 FR 76624; November 19, 1980). Since the PM&F wastes are not believed to be hazardous, no estimates were made of the costs to dispose of those wastes in accordance with RCRA hazardous waste requirements.

Although it is the Agency's view that solid wastes generated as a result of these guidelines are not expected to be classified as hazardous under the regulations implementing Subtitle C of the Resource Conservation and Recovery Act (RCRA), generators of these wastes must test the waste to determine if they meet any of the characteristics of hazardous waste. See 40 CFR Part 262.11 (45 FR 12732-12733; February 26, 1980). The Agency may also list these sludges as hazardous pursuant to 40 CFR Part 261.11 (45 FR at 33121; May 19, 1980, as amended at 45 FR 76624; November 19, 1980).

If these wastes are identified as hazardous, they will come within the scope of RCRA's "cradle to grave" hazardous waste management program, requiring regulation from the point of generation to point of final disposition. EPA's generator standards require generators of hazardous wastes to meet containerization, labeling, record keeping, and reporting requirements; if plastics molders or formers dispose of hazardous wastes off-site, they would have to prepare a manifest that tracks the movement of the wastes from the generator's premises to a permitted off-site treatment, storage, or disposal facility. See 40 CFR Part 262.20 (45 FR 33142; May 19, 1980, as amended at 45 FR 86973; December 31, 1980). The transporter regulations require transporters of hazardous wastes to comply with the manifest system to ensure that the wastes are delivered to a permitted facility. See 40 CFR Part 263.20 (45 FR 33142; May 19, 1980, as amended at 45 FR 86973; December 31, 1980). Finally, RCRA regulations establish standards for hazardous waste treatment, storage, and disposal facilities allowed to receive such wastes. See 40 CFR Part 264 (46 FR 2802; January 12, 1981, 47 FR 32274; July 26, 1982).

Even if these wastes are not identified as hazardous, they still must be disposed in a manner that will not violate the open dumping prohibition of §4005 of RCRA. The Agency has calculated as part of the costs for wastewater treatment the cost of hauling and disposing of these wastes in accordance with this requirement.

Consumptive Water Loss

Recycle of contact cooling and heating water requires the use of a cooling tower for PM&F processes with large flow rates. The evaporative cooling mechanism in a cooling tower can cause water loss and could contribute to water scarcity problems--a primary concern in arid and semi-arid regions. While the proposed regulation assumes water recycle through a cooling tower, the quantity of water loss in the cooling tower is not regionally significant. Thus, EPA concludes that the consumptive water loss is insignificant and that the effluent reduction benefits of recycle technologies outweigh their impact on consumptive water loss.

SECTION X

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

BACKGROUND

This section defines the effluent characteristics attainable through the application of best practicable control technology currently available (BPT), Section 301(b)(a)(A) of the Act. Effluent limitations guidelines for the PM&F category based on BPT reflect the existing treatment performance by plants of various sizes, ages, and manufacturing processes within the plastics molding and forming category and the performance of a treatment technology transferred from the organic chemicals, plastics, and synthetic fibers category.

The factors considered in identifying BPT include the total cost of applying the technology in relation to the effluent reduction benefits derived, the age of equipment and facilities involved, the manufacturing processes employed, energy, and non-water quality environmental impacts, and other factors EPA considers appropriate. In general, the BPT level represents the average of the best existing performance of plants of various ages, sizes, processes, or other common characteristics. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcatetory or category. Limitations based on transfer of technology are supported by a conclusion that the technology will be capable of achieving the prescribed effluent limitations guidelines. See, Tanners' Council of America v. Train, 540 F.2d 1188 (4th Cir. 1976). BPT focuses on end-of-pipe treatment rather than process changes or internal controls, except where such practices are common to the industry.

The cost-benefit inquiry for BPT is a limited balancing, committed to EPA's discretion, that does not require the Agency to quantify benefits in monetary terms. See, American Iron and Steel Institute v. EPA, 526 F.2d 1027 (3rd Cir. 1975). In balancing costs in relation to effluent reduction benefits, EPA considers the volume and nature of existing discharges, the volume and nature of discharges expected after application of BPT, the general environmental effects of the pollutants, and the cost and economic impacts of the required level of pollution control. The Act does not require or permit consideration of water quality problems attributable to particular point sources or industries, or water quality improvements in particular water bodies. Accordingly, water quality considerations were not the basis for selecting the proposed BPT effluent limitations guidelines for the PM&F category. See, Weyerhauser Company v. Costle, 590 F.2d 1011 (D.C. Cir. 1978).

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TECHNICAL APPROACH

The plastics molding and forming category was studied to identify the manufacturing processes used and the type of wastewaters generated during plastics molding and forming. Information was collected from the PM&F industry using questionnaires and PM&F wastewaters from selected plants were sampled and analyzed. EPA used these data to subcategorize the PM&F category and to determine what constitutes an appropriate BPT model treatment technology. Some of the key considerations reviewed to determine the subcategorization scheme for this category are:

1. raw materials,
2. production processes,
3. products,
4. size and age of plants,
5. wastewater characteristics,
6. water utilization, and
7. geographic location of plants.

The PM&F category has been divided for the purpose of the proposed regulation into two subcategories: (1) contact cooling and heating water subcategory and (2) cleaning and finishing water subcategory. Additional information on this subcategorization scheme is presented in Section V.

In making technical assessments of data, reviewing manufacturing processes, and assessing wastewater treatment technology options, both indirect and direct dischargers were considered as a single group. An examination of plants and processes did not indicate any process differences based on the type of discharge, whether it be direct or indirect. Therefore, it is appropriate to consider the data from both direct and indirect dischargers to make technical assessments for BPT.

The Agency is proposing mass-based BPT effluent limitations guidelines for the plastics molding and forming category. The objective of these effluent limitations guidelines and standards is to reduce the total quantity of pollutants discharged to surface waters. Mass-based effluent limitations guidelines and standards also avoid the possibility of concentration-based effluent limitations guidelines being met through dilution.

Because flow reduction by recycle of process water is an important part of the selected model BPT treatment technologies, the proposed effluent limitations guidelines for the PM&F category are expressed in terms of the allowable mass of pollutants discharged per unit of production. These mass-based effluent limitations guidelines reflect the reduction in the amount of pollutants discharged by PM&F processes through application of the model BPT treatment technologies.

Wastewater generated by processes in the contact cooling and heating water subcategory contains significant concentrations of BOD_5, COD, total phenols, and priority toxic pollutants. Wastewater generated by cleaning and finishing processes contains significant concentrations of BOD_5, oil and grease, TSS, COD, TOC, total phenols, and priority toxic pollutants. The technology options considered for BPT were analyzed for their ability to treat the above pollutants. Potential technology options were identified through examination of NPDES permits, questionnaire responses, and the literature.

BPT for the plastics molding and forming category is based on recycling contact cooling and heating water and cleaning and finishing water. For processes in the contact cooling and heating water subcategory with average process water usage flow rates of 35 gpm or less, BPT is based on zero discharge through 100 percent recycle. The BPT effluent limitations guidelines for recycle unit discharges that are treated and discharged are based on treatment in a package activated sludge plant that contains an equalization tank, a primary sedimentation unit, the activated sludge process, and a secondary sedimentation unit. pH adjustment is used as needed. Effluent concentrations for conventional pollutants for the activated sludge process were transferred from the organic chemicals, plastics, and synthetic fibers category.

The overall effectiveness of end-of-pipe treatment for the removal of wastewater pollutants is improved by the application of water flow controls within the process to limit the volume of wastewater requiring treatment. The in-process technologies under BPT include those measures that are commonly practiced within the PM&F category or subcategories.

For each of the subcategories, a specific approach was followed for the development of BPT effluent limitations guidelines. To account for production and flow variability from plant to plant, a unit of production or a production normalizing parameter was determined that could be related to the flow discharged from a process to determine a production normalized flow. Normalized flows were analyzed to determine which flow should be used as part of the basis for BPT effluent limitations guidelines. The selected flow (referred to as the BPT production normalized flow) reflects the water use controls that are currently used in the category. The BPT production normalized flow is based on the average of applicable data in the data base for this project. Plants with normalized flows above the average may have to reduce their flows. In most cases, this involves recycling a higher percentage of the process water. Plants may also achieve the BPT production normalized flow through more efficient water use practices, such as allowing process water to run only during production operations.

Effluent limitations guidelines (milligrams of pollutant per kilogram of plastic material processed) were developed for each subcategory. They were calculated by multiplying the BPT production normalized flow (l/kkg) by the concentration achievable using the BPT model treatment system (mg/l) for each pollutant regulated under BPT.

In summary, to establish the BPT effluent limitations guidelines for the PM&F category the Agency:

1. Selected a treatment technology on which to base the proposed BPT effluent limitations guidelines,
2. Selected pollutants that would be controlled,
3. Established effluent concentration values for the controlled pollutants,
4. Calculated BPT production normalized flows, and
5. Calculated the allowed mass of pollutant that can be discharged.

TREATMENT TECHNOLOGIES

Four treatment technologies were considered to treat the pollutants in the PM&F wastewater. These technologies are discussed in more detail in Section VIII of this document.

Technology 1: Sedimentation and pH Adjustment (if needed)

This technology consists of a tank in which the velocity of the wastewater is reduced so that solid material can settle by gravitational force. Oil and grease and other floatable material are skimmed from the surface. If necessary, the pH of the water may be adjusted by adding an acidic or basic material. Sedimentation is effective in removing insoluble pollutants such as total suspended solids and oil and grease but does not remove dissolved pollutants (e.g., biochemical oxygen demand).

Sedimentation is the most widely demonstrated technology used to treat PM&F wastewater. Sixty-five percent of the PM&F plants in the questionnaire data base that treat their wastewater use this technology.

Technology 2: Flow Reduction Through Recycle, Equalization, and Activated Sludge Treatment

Technology 2 consists of flow reduction through recycle with end-of-pipe treatment of the discharge from the recycle unit in a package activated sludge plant. Package activated sludge plants are commercially available to treat flows that would be discharged from the recycle units. A typical package activated sludge plant consists of a primary sedimentation unit where solids and oil and grease are removed; an aeration chamber where biodegradable organics are oxidized; and a secondary sedimentation unit where biological sludge settles by gravity. The biological sludge is returned to the aeration chamber. The activated sludge process is effective in removing dissolved and colloidal biodegradable organics from wastewater. The primary and secondary sedimentation units also remove settleable solids and floatable materials from wastewater.

Flow reduction through recycle is practiced at 42 percent of the processes in the contact cooling and heating water subcategory and 13 percent of the processes in the cleaning and finishing water subcategory. Activated sludge treatment is used only at integrated facilities where PM&F wastewater and other wastewater are combined for treatment. However, activated sludge treatment is widely demonstrated in other categories for the treatment of wastewaters similar to PM&F wastewater. In particular, it has been demonstrated in the treatment of wastewater generated by processes in the plastics only subcategory of the organic chemicals, plastics, and synthetic fibers category.

Activated sludge technology, when combined with sedimentation, treats the pollutants in PM&F wastewater.

Technology 3: Zero Discharge by 100 Percent Recycle of Process Water

Zero discharge is frequently achieved by processes in the contact cooling and heating water subcategory through 100 percent recycle of process water. There are 65 processes in the questionnaire data base for this project with process water usage flow rates of 50 gpm or less that have 100 percent recycle systems for contact cooling and heating water in place. These systems generally recycle water through a chiller or a tank to allow for heat transfer to the environment. Available information indicates that 100 percent recycle may also be achieved by processes with flow rates higher than 50 gpm.

Because of the characteristics of cleaning and finishing wastewater (i.e., high concentrations of solids and oil and grease) 100 percent recycle is not appropriate for cleaning and finishing water.

Technology 4: Zero Discharge by Contract Haul of Recycle Unit Discharge

Contract hauling of wastewater eliminates the discharge of wastewater pollutants. Two plants in the PM&F questionnaire data base currently contract haul cleaning and finishing water.

BPT TREATMENT TECHNOLOGY OPTIONS

Contact Cooling and Heating Water Subcategory

The Agency identified three technology options as the basis for the proposed BPT effluent limitations guidelines for the contact cooling and heating water subcategory. These options are based on the above described technologies. They are:

Option 1:

The technology for this option consists of a tank in which the velocity of the wastewater is reduced so that solid material can settle by gravitational force. This option was rejected early in the development of the proposed BPT effluent limitations guidelines because the suspended solids concentration in the contact cooling and heating water is very low and because this technology does not remove the dissolved pollutants (e.g., biochemical oxygen demand) in the contact cooling and heating water.

Option 2:

For processes with an average process water usage flow rate of 35 gallons per minute (gpm) or less - Zero discharge by 100 percent recycle of the process water using either a tank or chiller for heat transfer. The chiller based recycle system is depicted in Figure X-1.

For processes with an average process water usage flow rate greater than 35 gpm - Recycle through a cooling tower and treatment of the recycle unit discharge in a package activated sludge plant. An equalization tank is included as part of the package plant. The technology is represented by Figure X-2.

Data from the questionnaire surveys for this project indicate that 65 processes in this subcategory with a flow rate up to 50 gpm achieve 100 percent recycle. Of these processes, eight have a flow rate between 20 and 50 gpm and achieve 100 percent recycle of process water through a chiller. They are:

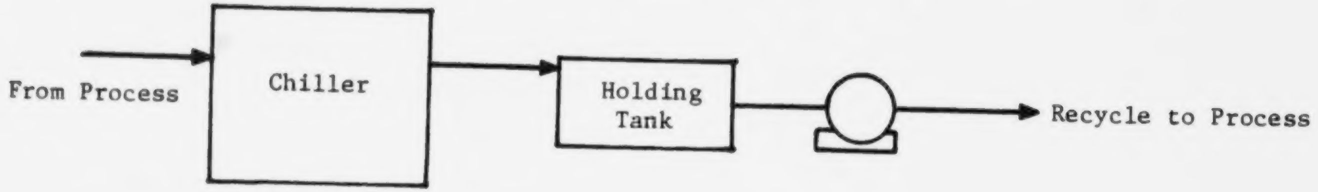

Figure X-1

CHILLER RECYCLE UNIT USED TO ACHIEVE 100 PERCENT RECYCLE OF PROCESS WATER - BPT OPTIONS 2 AND 3 CONTACT COOLING AND HEATING WATER SUBCATEGORY

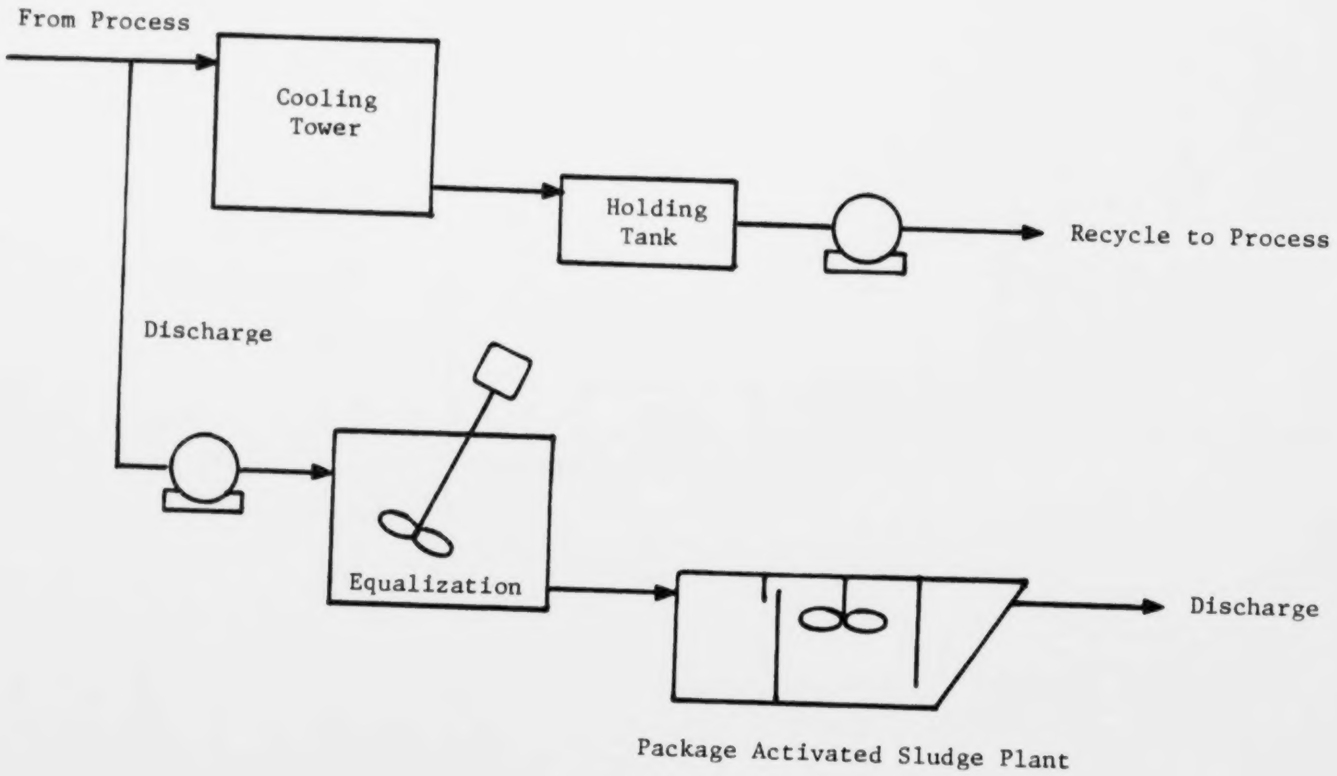

Figure X-2

TREATMENT TECHNOLOGY FOR PROCESSES WITH A PROCESS WATER USAGE GREATER THAN 35 GPM - BPT OPTION 2 CONTACT COOLING AND HEATING WATER SUBCATEGORY

Plant ID	Average Process Water Usage Flow Rate (gpm)
1178	22
750	30
830	30
1061	30
10180	33.3
2020	33.3
10780	40
1945	50

The Agency considered the flow rates for these eight processes the "best" flow rates for processes that recycle 100 percent of the process water using chillers. To obtain the flow cut-off of 35 gpm, the Agency averaged the "best" flow rates. Above 50 gpm, a cooling tower is most commonly used to recycle process water. A cooling tower necessarily includes some amount of discharge, which is treated in a package activated sludge plant in this option.

Option 3:

For processes with an average process water usage flow rate of 35 gpm or less - Zero discharge by 100 percent recycle of the wastewater through either a tank or a chiller. This is the same technology as depicted in Figure X-1.

For processes with an average process water usage flow rate greater than 35 gpm - Recycle through a cooling tower and zero discharge by contract haul of the discharge from the recycle unit. This technology is represented by Figure X-3.

The 35 gpm flow rate was used as the cut-off for this option for the same reasons it was used in Option 2. A cooling tower is also used in this option to recycle process water for processes with an average process water usage flow rate greater than 35 gpm. However, the recycle unit discharge is contract hauled to achieve zero discharge instead of being treated at the plant and discharged.

Contract haul was used in this option to handle the discharge from the recycle unit because treatment technologies other than those used in Option 2 are not considered feasible for the PM&F category. Technologies (e.g., activated carbon) that could be used to treat PM&F wastewater are expensive and are difficult to operate and maintain. The Agency considers contract haul more practicable for this subcategory than those technologies.

The estimated amounts of pollutants remaining after treatment for each technology option are:

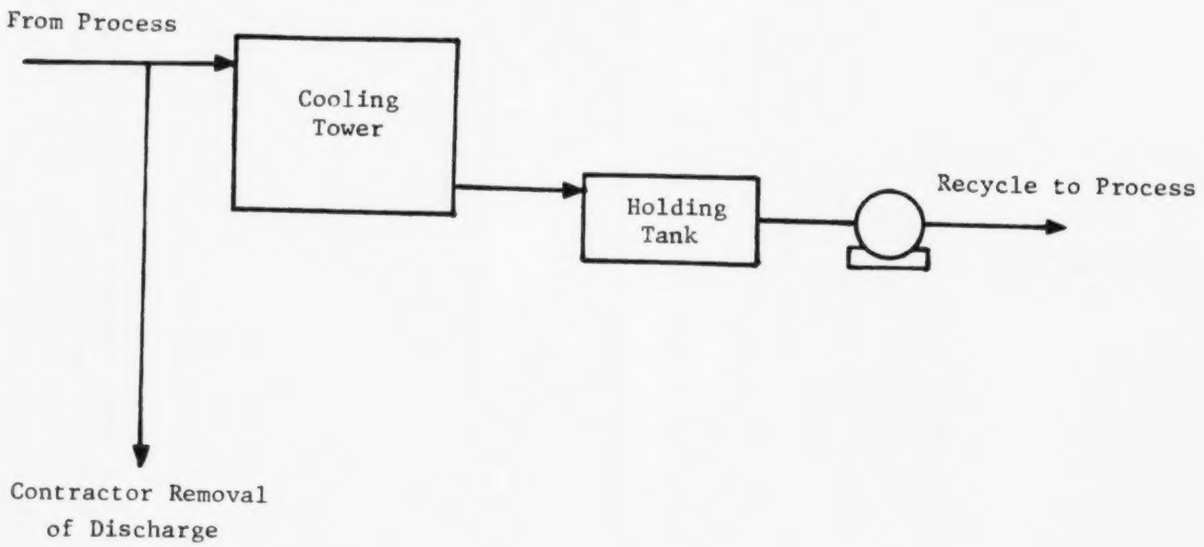

Figure X-3

TREATMENT TECHNOLOGY FOR PROCESSES WITH A PROCESS WATER USAGE
GREATER THAN 35 GPM - BPT OPTION 3
CONTACT COOLING AND HEATING WATER SUBCATEGORY

Type of Pollutant	Discharged in Raw Water (kg/yr)	Remaining After Option 1 (kg/yr)	Remaining After Option 2 (kg/yr)	Remaining After Option 3 (kg/yr)
Conventional	8,923,000	8,923,000	1,485,200	0
Nonconventional	27,243,000	27,243,000	5,753,200	0
Priority Toxic	123,845	123,845	24,469	0

The methodology used to calculate the pollutant removals for each option is presented in Appendix C.

The estimated investment cost and annual pollution control costs for BPT Options 2 and 3 are:

	Cost ($ million, 1982 dollars)	
	Option 2	Option 3
Investment Costs	15.2	9.3
Annual Pollution Control Costs*	9.4	41.2

*Without water savings.

Detailed information on these costs is presented in Economic Impact Analysis of Proposed Effluent Limitations and Standards for the Plastics Molding and Forming Industry, EPA 440/2-84-001, February 1984.

Option Selected. The Agency is proposing Option 2 as the model technology basis for BPT effluent limitations guidelines for the contact cooling and heating water subcategory. There are 65 processes in the contact cooling and heating water subcategory in the questionnaire data base with flow rates of 50 gpm or less that report 100 percent recycle. Further, those plants reported that the only wastes from this technology result from occasional cleaning of the recycle units (i.e., once every one to two years).

The proposed BPT effluent limitations guidelines for processes with an average process water usage flow rate of 35 gpm or less require zero discharge of the wastewater. The "average process water usage flow rate" is the volume of process water used per year by a process divided by the total time per year the process operates. The "average process water usage flow rate" for a plant with more than one PM&F process that uses contact cooling and heating water is the sum of the "average process water usage flow rates" for each of these processes. The sum of the average process water usage flow rates determines if a plant has processes in the contact cooling and heating water subcategory with an average process water usage flow rate less than, equal to, or greater than 35 gpm.

The proposed BPT effluent limitations guidelines for processes with an average process water usage flow rate greater than 35 gpm are based on recycle through a cooling tower and treatment of the recycle unit discharge in a package activated sludge plant. The activated sludge process is only demonstrated at integrated treatment facilities that treat PM&F wastewater combined with wastewater discharged by other industrial processes. Treatment at plants that discharge PM&F wastewater separately is uniformly inadequate because these plants indicated that they use only sedimentation and oil skimming, which does not remove dissolved pollutants. Activated sludge technology has been demonstrated in other categories to effectively treat the conventional pollutants that are in PM&F wastewater. In particular, the activated sludge process has been demonstrated in the organic chemicals, plastics, and synthetic fibers category. Therefore, the activated sludge process and conventional pollutant performance data for that process were transferred from the organic chemicals, plastics, and synthetic fibers category to the PM&F category.

The Agency estimates that the proposed BPT effluent limitations guidelines for this subcategory result in the removal of approximately 7.4 million kilograms of conventional pollutants per year, 21.5 million kilograms per year of nonconventional pollutants, and 99,000 kilograms per year of priority toxic pollutants from the raw wastes. The estimated investment costs and total annual costs in 1982 dollars for the proposed BPT effluent limitations guidelines are $15.2 million and $9.4 million, respectively. The Agency has determined that the effluent reduction benefits associated with compliance with BPT justify the costs.

The Agency has concluded that the increased production of solid wastes caused by the implementation of the proposed BPT will not cause any significant negative environmental impact. Increased electrical engery usage will be insignificant. Support for these conclusions is presented in Section IX of this document.

Cleaning and Finishing Water Subcategory

The Agency identified three technology options for the basis for the proposed BPT effluent limitations guidelines for the cleaning and finishing water subcategory. These options are based on technologies described earlier in this section.

Option 1:

The technology for this option consists of a sedimentation tank in which the velocity of the wastewater is reduced so that solid material can settle by gravitational force. Acidic or basic material is added to either the tank influent or the tank effluent to adjust the pH of the wastewater. The Option 1 technology is represented in Figure X-4.

Option 2:

This option consists of recycle through a sedimentation tank and treatment of the discharge from the recycle unit in a package activated sludge plant. The package plant includes an equalization unit and pH adjustment. A sedimentation tank is used to remove the suspended solids and oil and grease in the process water so that the water can be recycled. Suspended solids and oil and grease are found in high concentrations in cleaning and finishing water. The Option 2 technology is represented in Figure X-5.

Option 3:

Option 3 consists of recycle through a sedimentation tank and contract haul of the discharge from the recycle unit. A sedimentation tank is used to remove the suspended solids and oil and grease in the process water so that the water can be recycled. The Option 3 technology is represented in Figure X-6.

The estimated amounts of pollutants remaining for each technology option are:

Type of Pollutant	Discharged in Raw Water (kg/yr)	Remaining After Option 1 (kg/yr)	Remaining After Option 2 (kg/yr)	Remaining After Option 3 (kg/yr)
Conventional	711,600	286,600	68,440	0
Nonconventional	939,200	413,600	134,680	0
Priority Toxic	890	633	104	0

The methodology used to calculate the pollutant removals for each option are presented in Appendix C.

The estimated investment cost and annual pollution control costs for BPT Options 1, 2, and 3 are:

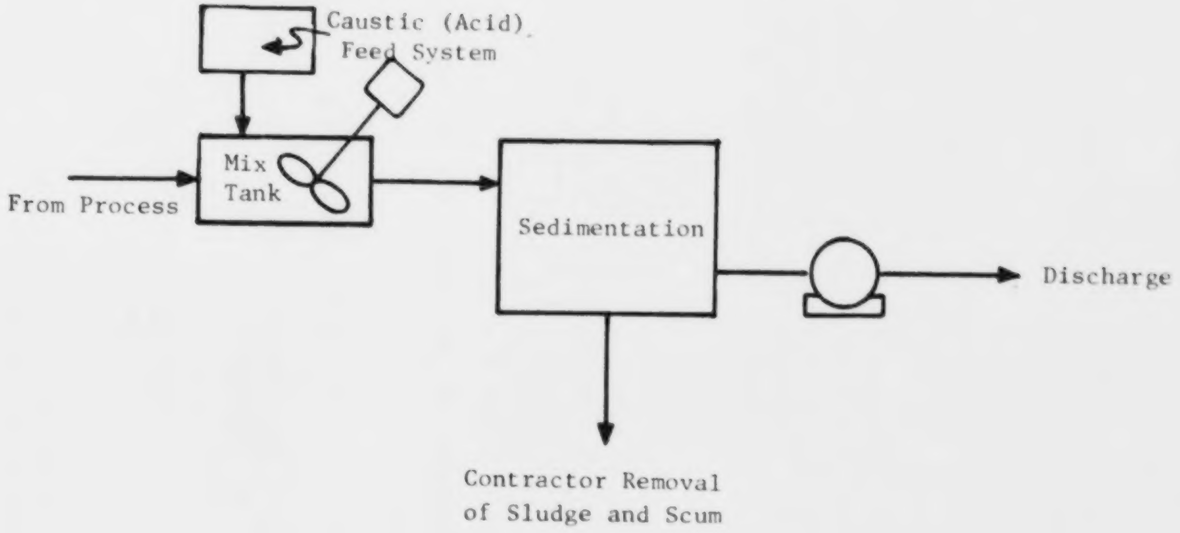

Figure X-4

BPT OPTION 1
CLEANING AND FINISHING WATER SUBCATEGORY

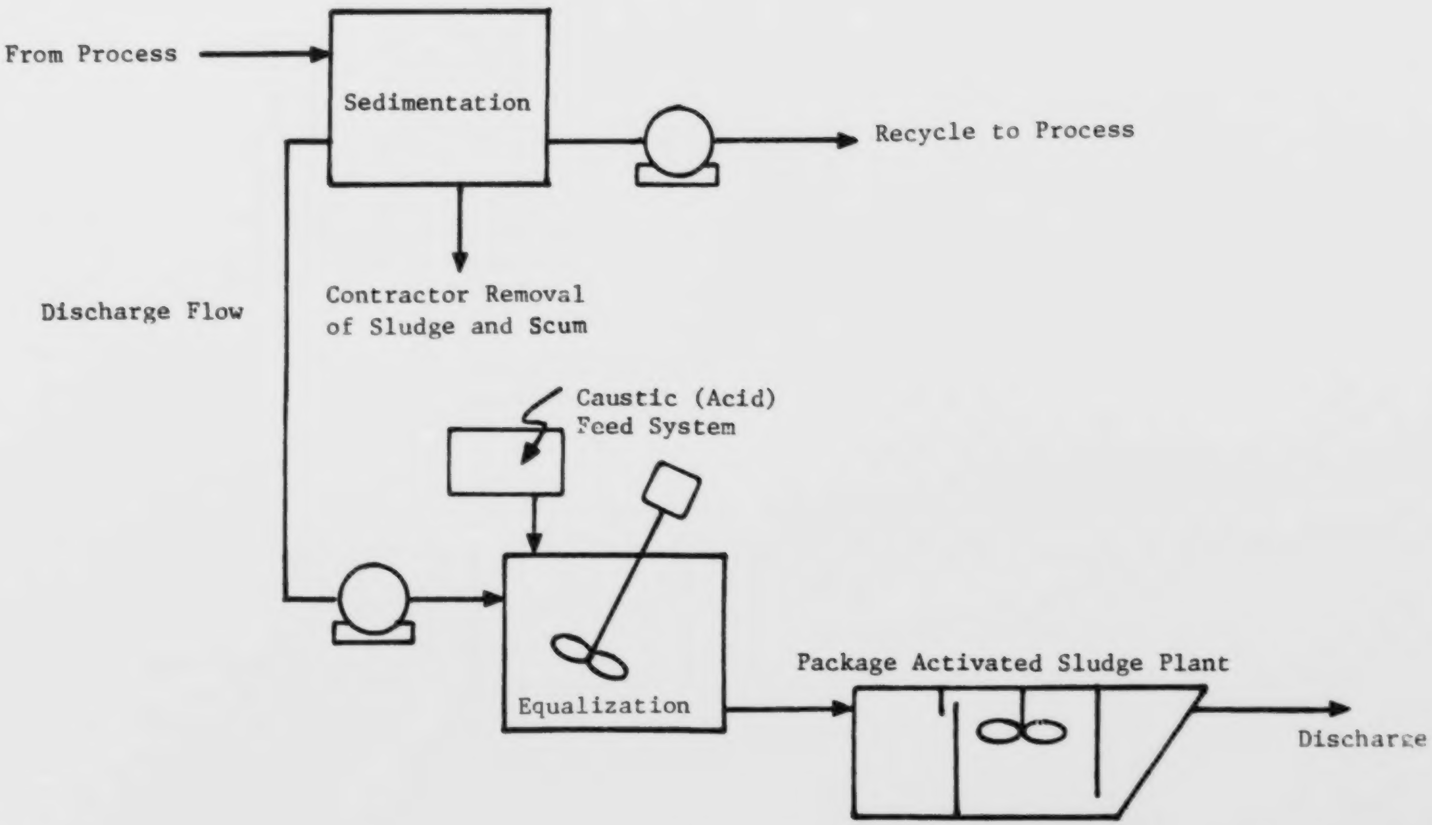

Figure X-5

BPT OPTION 2
CLEANING AND FINISHING WATER SUBCATEGORY

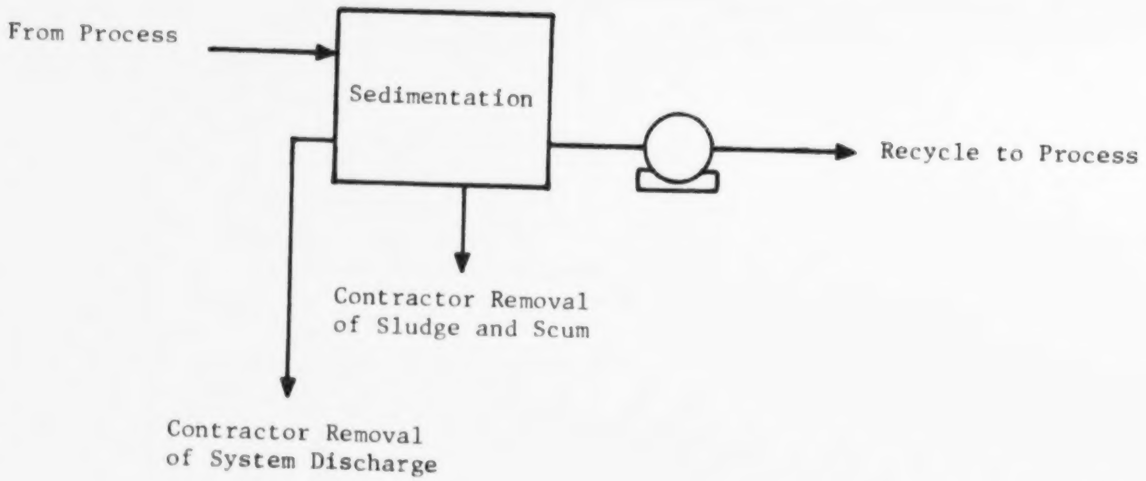
From Process
Sedimentation
Recycle to Process
Contractor Removal of Sludge and Scum
Contractor Removal of System Discharge

Figure X-6

BPT OPTION 3
CLEANING AND FINISHING WATER SUBCATEGORY

	Cost ($million, 1982 dollars)		
	Option 1	Option 2	Option 3
Investment Costs	1.4	2.0	1.2
Annual Pollution Control Costs*	1.0	1.5	6.0

*Without water savings.

Detailed information on these costs are presented in Economic Impact Analysis of Proposed Effluent Limitations and Standards for the Plastics Molding and Forming Industry, EPA 440/2-84-001, February 1984.

Option Selected. The Agency is proposing Option 2 as the technology basis for the BPT effluent limitations guidelines for this subcategory. Thirteen percent of the cleaning and finishing processes in the questionnaire data base recycle process water. End-of-pipe treatment for cleaning and finishing water is uniformly inadequate because PM&F plants treating only PM&F wastewater indicated that they currently use only sedimentation and oil skimming, which does not treat dissolved pollutants (i.e., biochemical oxygen demand). Therefore, the activated sludge process and conventional pollutant effluent data for that process were transferred from the organic chemicals, plastics, and synthetic fibers category to this subcategory.

The Agency estimates that the proposed BPT effluent limitations guidelines result in the removal of 643,000 kilograms per year of conventional pollutants, 804,000 kilograms per year of nonconventional pollutants, and 786 kilograms per year of priority pollutants from the raw waste. The estimated total investment costs and total annual costs for the proposed BPT effluent limitations guidelines are $2.0 million and $1.5 million, respectively. The Agency has determined that the costs are justified by the effluent reduction benefits.

The Agency has concluded that the increased production of solid wastes caused by the implementation of the proposed BPT will not cause any significant negative environmental impact. Increased electrical energy usage will be insignificant. Support for these conclusions is presented in Section IX of this document.

REGULATED POLLUTANTS OR POLLUTANT PROPERTIES

Pollutants or pollutant properties were selected for regulation in the plastics molding and forming subcategories because of their frequency of occurrence and concentration in PM&F wastewaters. Biochemical oxygen demand, total suspended solids, oil and grease, and pH are controlled in the proposed regulation for each subcategory.

Biochemical oxygen demand (BOD_5) was found in contact cooling and heating water at concentrations up to 1,000 mg/l. Its presence was detected in cleaning and finishing water at concentrations up to 540 mg/l. BOD_5 is a parameter widely used to determine the organic content of wastewater. BOD_5 is also an important control parameter for the activated sludge treatment process; the reduction of BOD_5 indicates an overall reduction of organic pollutants.

Total suspended solids were found in contact cooling and heating water at concentrations up to 104 mg/l. TSS was found in cleaning and finishing water at concentrations up to 16,400 mg/l.

Oil and grease was detected in contact cooling and heating water at concentrations up to 73 mg/l and in cleaning and finishing water at concentrations up to 684 mg/l.

For protection of aquatic life and human welfare, pH of wastewater should be between 6.0 and 9.0. The pH of PM&F wastewater is regulated because the pH of contact cooling and heating water was found to range between 5.4 and 8.3 and the pH of cleaning and finishing water was found to range between 1.6 and 11.5.

The Agency proposes to establish effluent limitations guidelines for biochemical oxygen demand, total suspended solids, oil and grease, and pH. The Agency estimates that when these limitations are met approximately 79 percent of the amount of nonconventional pollutants discharged by PM&F processes and approximately 80 percent of the amount of priority toxic pollutants discharged will be removed. These estimates are based on removal percentages reported in the literature and previous EPA studies for the nonconventional and priority toxic pollutants. The nonconventional and priority toxic pollutants in PM&F wastewater are listed in Table VII-5.

Although the proposed model treatment technology removes approximately 79 percent of the amount of nonconventional pollutants in PM&F wastewater, a substantial amount of these pollutants remain in the discharge. The Agency estimates that the remaining amount of nonconventional pollutants results in a discharge of approximately 48 kilograms per day per direct discharger in this subcategory. The impact of this amount is not known. For this reason, the Agency plans to study the nonconventional pollutants, particularly bulk organic parameters such as chemical oxygen demand and total organic carbon. Depending on the results of that work, the Agency may consider additional controls for the nonconventional pollutants.

EFFLUENT CONCENTRATION VALUES

The activated sludge treatment process is the end-of-pipe treatment technology selected as BPT for both subcategories. The activated sludge process and performance data for that process were transferred from the organic chemicals, plastics, and synthetic fibers category because wastewater generated by processes in that category and PM&F wastewater had similar conventional pollutant characteristics.

The transfer of the activated sludge process was analyzed by comparing the sampling data obtained during the sampling program for this project to process wastewater data from the organic chemicals, plastics, and synthetic fibers category, particularly the plastics only subcategory. That comparison showed that the raw wastewater for the two categories have similar characteristics. Specifically, data on raw waste concentrations of BOD_5, TSS, and oil and grease were examined statistically. A detailed report on the statistical analysis is presented in Appendix D. Results of that analysis show that the concentrations for these pollutants in PM&F wastewater are neither significantly greater nor more variable than the concentrations of those pollutants in wastewater generated by processes at plants that manufacture plastics. This supports the Agency's technical judgment that the activated sludge process will treat PM&F wastewater effectively and achieve the conventional pollutant effluent concentrations achieved by activated sludge processes that treat wastewater generated by processes at plastics manufacturing plants in the organic chemicals, plastics, and synthetic fibers category. The Agency's judgment that the activated sludge process will treat PM&F wastewater was based on the literature and knowledge of the performance of the activated sludge process.

Thus, the Agency transferred the activated sludge technology and treated effluent data for that technology from the organic chemicals, plastics, and synthetic fibers category to the PM&F category. Effluent concentration values were transferred for biochemical oxygen demand, total suspended solids, and oil and grease. The transferred effluent concentration values are:

Pollutant	Maximum Concentration for One Day (mg/l)	Maximum Monthly Average Concentration (mg/l)
BOD_5	49	22
Oil and Grease	71	17
TSS	117	36

The concentration values were used to calculate the mass based effluent limitations guidelines for both subcategories.

BPT PRODUCTION NORMALIZED FLOWS

The BPT model treatment technologies for this category (Option 2 for both subcategories) reflect the water use controls currently used by plants in the PM&F category. BPT production normalized flows were established to relate the quantity of wastewater discharged to a unit of production. When the quantity of wastewater discharged is expressed as a volume per unit of production, wastewater discharged by different sized processes can be compared on an equal basis.

Contact Cooling and Heating Water Subcatgory

Production Normalizing Parameter. The production normalizing parameter used to calculate the production normalized flows in the contact cooling and heating water subcategory is mass of plastic material processed. Mass of plastic material processed was chosen as the normalizing parameter because in a cooling or heating process the volume of cooling or heating water required is directly related to the mass of plastic material processed. The quantity of heat transferred from or to plastic material upon cooling or heating under isobaric conditions can be expressed as:

$$Q = m \cdot \int_{T_1}^{T_2} Cp \; dT \qquad \text{(Faires \& Simmang)}$$

where: Q = quantity of heat transferred
m = mass of plastic material processed
Cp = heat capacity of the material
T = temperature.

Thus the quantity of heat transferred, Q, is directly related to the mass of plastic material processed, m.

The basic thermodynamic equation stated above is universal. It can also be used to describe the quantity of heat transferred to or from the contact cooling or heating water. The mass of cooling or heating water required is directly related to the quantity of heat to be supplied or removed by the water. Because the quantity of heat transferred to the water is equal to the quantity of heat transferred from the plastic material, the mass of cooling or heating water required is directly related to the mass of plastic material processed. Assuming the density of water is constant, the volume of cooling or heating water required is also directly related to the mass of plastic material processed.

Examination of Discharge Flow Rates. To establish a baseline on which to compare processes in the contact cooling and heating water subcategory, the volume of water discharged by each process in the data base for this subcategory was divided by the mass of plastic material processed by that process. Individual production normalized flows for each process were thus established in terms of liters per metric ton (kkg) of plastic material processed.

The production normalized flows for the processes in the contact cooling and heating water subcategory exhibited some variability. Processes with production normalized flows in both the low end and high end of the spectrum were examined for factors that would explain why they were either high or low. Particular attention was given to the production process employed, such as molding, extrusion of profiles and extrusion of wire and cable coating. No trend was found among different processes indicating different water use requirements. The types of plastic material processed were also examined. There was nothing to indicate that the type of plastic material processed influenced the quantity of water discharged. Thus, the Agency concluded that the quantity of cooling or heating water used is independent of the type of process or type of plastic material processed. The only factor that had a distinguishable bearing on the quantity of process water discharged was the use of recycle units. As would be expected, processes that recycled contact cooling and heating water discharged less process water per metric ton of plastic material processed than processes that do not recycle process water.

BPT Production Normalized Flows. The proposed BPT for processes in the contact cooling and heating water subcategory with an average process water usage flow rate of 35 gpm or less is 100 percent recycle. The BPT production normalized flow for these processes is zero because no process water is discharged.

The proposed BPT for processes in the contact cooling and heating water subcategory with an average process water usage flow rate greater than 35 gpm is based on recycle of process water. The BPT production normalized flow for these processes is the average of the best production normalized flows for processes in the data base that recycle process water.

The average of the best was calculated by averaging production normalized flows for processes with recycle percentages between 90.0 and 99.9 percent (i.e., 48 of the 183 processes in the data base that recycle process water). Ninety-five of the other 135 processes were not used to calculate the average because they either had an average process water usage flow rate of 35 gpm or less and thus, are controlled by effluent limitations guidelines based on zero discharge (i.e., 100 percent recycle) or had a recycle percentage below 90.0. The remaining 40 of the 135 processes with an average process water usage flow rate greater than 35 gpm were not used because the Agency is uncertain about their reported recycle percentage of 100 percent. Most of those processes indicated they achieved 100 percent recycle using a cooling tower. The Agency questions whether 100 percent recycle can be achieved using a cooling tower. When a cooling tower is used to recycle water there is necessarily a discharge from the cooling tower even though no discharge was shown in the questionnaire.

The 48 processes that have an average process water usage flow rate greater than 35 gpm and that recycle between 90.0 percent and 99.9 percent of the process water are presented in Table X-1. The average production normalized flow for these processes was calculated by dividing the total volume of process water discharged per year from these processes by their total annual production. The average production normalized flow for these processes is 1,589 l/kkg. This value is the BPT production normalized flow for processes in the contact cooling and heating water subcategory with average process water flows above 35 gpm.

The Agency compared the BPT production normalized discharge flow of 1,589 l/kkg to the production normalized discharge flows of the recycle processes in the data base. All of these processes either have production normalized discharge flows below the BPT production normalized flow or can reduce their flows to the BPT production normalized flow by increasing their recycle rates within demonstrated limits.

Cleaning and Finishing Water Subcategory

Production Normalizing Parameter. Before a regulatory flow allowance was established for processes in the cleaning and finishing water subcategory a production normalizing parameter for the subcategory was chosen. Number of products processed, surface area of material processed, and mass of plastic material processed were considered as possible production normalizing parameters.

The number of products processed was examined as a possible production normalizing parameter. However, using the number of products processed as a production normalizing parameter does not account for the variations in size and shape of molded and formed products. The cleaning or finishing of a large product does not require the same amount of water needed to clean or finish a small product. Therefore, the Agency concluded that the number of products processed is not an appropriate production normalizing parameter.

Surface area was considered as a production normalizing parameter for processes in the cleaning and finishing water subcategory.

Table X-1

RECYCLE PROCESSES* USED TO CALCULATE BPT PRODUCTION NORMALIZED FLOWS CONTACT COOLING AND HEATING WATER SUBCATEGORY

Plant I.D.	Production (kkg/yr)	Water Used (l/yr)	Percent Recycle	Water Discharged (l/yr)	Production Normalized Flow (l/kkg)
3070	2,187	227,572,597	99.9	18,805	9
10781	2,291	14,200,000	99.8	23,700	10
10377	3,025	88,600,000	99.9	28,600	10
10376	1,653	46,600,000	99.9	38,000	23
833131K	2,722	95,468,394	99.9	75,708	28
3200	27,032	8,759,671,247	99.9	844,114	31
362544N	1,497	141,770,000	99.9	49,210	33
653769Y	2,359	104,360,000	99.9	43,154	46
653769AA	5,443	275,960,000	99.9	123,026	52
653769Z	953	51,515,403	99.9	757	56
76001A	1,406	388,080,000	99.9	111,000	79
3210	10,478	1,364,855,988	99.9	935,000	89
30	2,097	5,905,224	96.7	194,811	93
391771E	11,902	1,143,072,000	99.9	1,180,000	99
500	2,412	307,680,000	99.9	245,521	102
833131F	12,701	142,090,000	99	1,362,744	110
581	17,533	583,780,000	99.7	1,945,998	111
10371	1,665	76,900,000	99.7	250,000	150
510	3,985	741,710,000	99.9	741,643	186
10460	68,000	5,360,000,000	99.6	19,500,000	292
10791	3,047	59,000,000	98	1,160,000	380
1550	142	62,079,018	99.9	62,338	439
581	17,533	651,920,000	98	9,729,992	555
582	14,269	1,307,100,000	99.1	11,675,991	818
644737WW	4,445	572,350,000	99.3	3,815,693	858
280	34,700	373,940,000	91.5	31,860,955	918
275857	3,402	340,690,000	99	3,936,816	1,152
1945	5,977	183,000,000	95.8	7,550,000	1,260
4015940	3,039	380,430,000	98.6	5,034,393	1,657
10280	21,106	753,000,000	95.3	35,400,000	1,680
644737BB	21,221	2,697,900,000	98.7	35,961,300	1,695
958218G	2,495	122,650,000	96.3	4,504,626	1,813
958218B	7,504	379,520,000	95.5	17,072,154	2,276
1060	14,866	1,007,300,000	96.5	35,714,795	2,402
120	1,858	97,163,647	95.4	4,469,145	2,406
731687A	3,428	587,380,000	98	11,197,213	3,266
580	13,918	1,479,900,000	96	59,158,352	4,251
940	5,718	583,900,000	95.7	25,794,018	4,511
833131A	30,495	3,372,800,000	95	168,637,350	5,530
250	12,076	883,970,000	92	69,445,434	5,759
330	2,744	385,510,000	95	19,194,412	6,995
1945	1,031	275,000,000	95.8	11,400,000	11,100
10780	348	48,100,000	91.4	4,140,000	11,900
10780	523	72,100,000	91.4	6,210,000	11,900
2670	798	380,309,693	91.3	9,652,530	12,105
1000002I	1,738	270,480,000	91.6	22,712,400	13,068
10720	513	102,000,000	93	7,120,000	13,900
644737BB	41	102,700,000	99	1,369,395	33,073

*Processes in project data base.

The Agency believes there may be a correlation between the volume of cleaning and finishing water used and the surface area of plastic product cleaned or finished. However, records of the area of the plastic product cleaned or finished are generally not kept by industry. In some cases, such as for cast or molded complex shapes, surface area is very difficult if not impossible to determine. For these reasons, surface area is an inappropriate production normalizing parameter for the cleaning and finishing water subcategory.

Mass of plastic material processed was selected as the appropriate production normalizing parameter for the cleaning and finishing subcategory because even though data correlating mass of pollutant discharged to mass of plastic materal processed are limited, the Agency believes that the mass of pollutants generated is proportional to the mass of plastic material processed. Additionally, the plastics molding and forming industry typically maintains records on the basis of mass of plastic material cleaned or finished.

Examination of Discharge Flow Rates. The proposed BPT for the cleaning and finishing water subcategory is based on recycle. Therefore, processes in the data base for the cleaning and finishing water subcategory that currently recycle process water were analyzed to establish regulatory flows for this subcategory. To establish a baseline from which to compare the discharge flows from the recycling processes, mass of plastic material processed was used as the production normalizing parameter. The volume of water discharged by each recycling process was divided by the reported mass of plastic material processed in that process to obtain a production normalized discharge flow in units of liters per kilogram of plastic material processed. The production normalized flows for processes in this subcategory (i.e., product cleaning, shaping equipment cleaning, and finishing) were reviewed. As a result of this review, different BPT production normalized flows were calculated for the washing and rinsing of molded or formed parts and shaping equipment and the finishing of products because based on questionnaire data the washing and rinsing of molded or formed parts and shaping equipment requires more water than the finishing of plastic products.

BPT Production Normalized Flows

Cleaning Water:

The BPT production normalized flow for cleaning processes is the average production normalized flow for all cleaning processes in the questionnaire data base that recycle cleaning water. Data for these processes are presented in Table X-2. The BPT production normalized flow was calculated by dividing the total quantity of wastewater discharged by total mass of plastic material

Table X-2

RECYCLE PROCESSES USED TO CALCULATE BPT PRODUCTION NORMALIZED FLOW CLEANING AND FINISHING WATER SUBCATEGORY

CLEANING WATER

Plant I.D.	Production (kkg/yr)	Water Used (l/yr)	Percent Recycle	Water Discharged (l/yr)	Production Normalized Flow (l/kkg)
510	3,985	703,800,000	99.9	394,147	163
500	2,412	664,250,000	99.9	692,751	287
820	635	390,000,000	99.3	2,740,000	4,291
1420	2,226	272,000,000	90	30,000,000	13,500
1000001N	85.8	111,510,000	98	1,947,815	22,702
1950	168	38,155,884	85.7	5,450,841	32,478
1000001N	40	91,188,549	98	1,583,781	39,203

processed by those processes. The BPT production normalized flow for cleaning processes in the cleaning and finishing water subcategory is 4,483 l/kkg. A cleaning process includes both detergent washing and rinsing operations.

The Agency compared the BPT production normalized flow of 4,483 l/kkg to the production normalized discharge flows of the seven processes that recycle cleaning water. Five of those processes either have production normalized discharge flows below the BPT production normalized flow or can reduce their flows to the BPT production normalized flow by increasing their recycle rates within demonstrated limits. Two processes will have to reduce their process water usage flow rates to meet the BPT production normalized flow.

Finishing Water:

The BPT production normalized flow for finishing processes is the average production normalized flow for all finishing processes in the questionnaire data base that recycle finishing water. Data for these processes are presented in Table X-3. The BPT production normalized flow was calculated by dividing the total quantity of wastewater discharged by the total mass of plastic material processed by those processes. The BPT production normalized flow for finishing processes in the cleaning and finishing water subcategory is 1,067 l/kkg. This BPT production normalized flow is based on a limited number of data points. However, the Agency believes the allowance is reasonable based on a comparison of this PNF to the PNFs for finishing processes that currently recycle process water.

All finishing processes that recycle process water have production normalized discharge flows below the BPT production normalized discharge flow or can reduce their flows to the BPT production normalized flow by increasing their recycle rates within demonstrated limits.

BPT EFFLUENT LIMITATIONS GUIDELINES

BPT effluent limitations guidelines were calculated by multiplying the BPT production normalized flow by the BPT effluent concentration values transferred from the organic chemicals, plastics, and synthetic fibers category (see Appendix D). Both one day maximum and monthly average concentration values were transferred. The BPT effluent limitations guidelines are presented below.

Table X-3

RECYCLE PROCESSES USED TO CALCULATE BPT PRODUCTION NORMALIZED FLOW CLEANING AND FINISHING WATER SUBCATEGORY

FINISHING WATER

Plant I.D.	Production (kkg/yr)	Water Used (l/yr)	Percent Recycle	Water Discharged (l/yr)	Production Normalized Flow (l/kkg)
480	640	445,160,000	100	0	0
2860	18	2,271,184	100	0	0
2500	2,106	9,850,000	70	2,950,000	1,400

Contact Cooling and Heating Water Subcategory

Contact cooling and heating water is process water that contacts the raw materials or plastic product for the purpose of heat transfer during the plastic molding and forming process.

Average Process Water Usage Flow Rate of 35 gpm or Less. For processes with an average process water usage flow rate of 35 gpm or less, the BPT production normalized flow is zero discharge. Therefore, no wastewater pollutants can be discharged from these processes.

Average Process Water Usage Flow Rate Greater Than 35 gpm. For processes with an average process water usage flow rate greater than 35 gpm, the BPT effluent limitations guidelines are:

Contact Cooling and Heating Water

Pollutant or Pollutant Property	BPT Effluent Limitations Maximum For Any One Day (mg/kg)	BPT Effluent Limitations Maximum For Monthly Average (mg/kg)
BOD_5	78	35
Oil and Grease	113	27
TSS	186	57
pH	(1)	(1)

(1) Between 6.0 and 9.0.

The effluent limitations guidelines are expressed as milligrams of pollutant per kilogram of plastic material processed. Kilograms of plastic material processed when used to determine effluent limitations guidelines are the mass of plastic material that process water comes in contact with for cooling or heating purposes. If the same unit mass of plastic undergoes more than one molding and forming process (for example, it is compounded and pelletized, extruded, and blow molded), the mass of plastic material processed in each process is added to obtain the total mass of plastic material processed.

Cleaning and Finishing Water Subcategory

Cleaning Water. Cleaning water is process water used to clean an intermediate or final plastic product or to clean the surfaces of product shaping equipment, such as molds and mandrels, that are or have been in contact with the plastic product. It includes water used in both the detergent wash and rinse cycles of a cleaning process.

The mass of pollutants discharged by existing processes in the cleaning and finishing water subcategory that use cleaning water shall not exceed:

Cleaning Water

Pollutant or Pollutant Property	BPT Effluent Limitations Maximum For Any One Day (mg/kg)	 Maximum For Monthly Average (mg/kg)
BOD_5	220	99
Oil and Grease	318	76
TSS	524	161
pH	(1)	(1)

(1) Between 6.0 and 9.0.

These effluent limitations guidelines are expressed as milligrams of pollutant per kilogram of plastic material processed. Kilograms of plastic material processed when used to determine effluent limitations guidelines are the mass of plastic material that process water comes in contact with for product cleaning purposes. For the purpose of calculating limitations for water used to clean shaping equipment, such as molds and mandrels, mass of plastic material processed refers to the mass of plastic material that was molded or formed by the shaping equipment being cleaned. These discharge allowances apply to the combined discharge from the detergent wash and rinse cycle of a cleaning process. Separate allowances are not given for the wash and rinse cycles.

Finishing Water. Finishing water is process water used to remove waste plastic material generated during a finishing process or to lubricate a plastic product during a finishing process. It includes water used to machine, to decorate, or to assemble intermediate or final plastic products.

The mass of pollutants discharged by existing processes in the cleaning and finishing water subcategory that use finishing water shall not exceed:

Finishing Water

Pollutant or Pollutant Property	BPT Effluent Limitations	
	Maximum For Any One Day (mg/kg)	Maximum For Monthly Average (mg/kg)
BOD_5	52	23
Oil and Grease	76	18
TSS	125	38
pH	(1)	(1)

(1) Between 6.0 and 9.0.

These effluent limitations are expressed as milligrams of pollutant per kilogram of plastic material processed. Kilograms of plastic material processed are the mass of plastic material that process water comes in contact with for finishing purposes.

EXAMPLE OF THE APPLICATION OF THE BPT EFFLUENT LIMITATIONS GUIDELINES

The purpose of the BPT effluent limitations guidelines is to provide a uniform basis for regulating wastewater discharged from processes in the plastics molding and forming category. For direct dischargers, this is accomplished through NPDES permits. The plastics molding and forming category is regulated on an individual wastewater flow "building block" approach. An example that illustrates how the effluent limitations guidelines are used to determine the amount of pollutants that can be discharged from plastics molding and forming plants is presented below.

Example

Plant X compounds and pelletizes 1,250,000 kilograms of polyethylene per year. The pelletizing process uses contact cooling water. Thirty percent of this amount is then extruded in a process using contact cooling water; the remainder is processed by injection molding in a process that uses non-contact cooling water. The injection molds are cleaned with process water. Fifty percent by weight of the injection molded plastic parts are trimmed in a finishing process that uses process water. The average process water usage flow rate for the pelletizing process is 65 gpm; the average process water usage flow rate for the extrusion process is 20 gpm. The plant operates 250 days per year.

The daily production from the compounding and pelletizing process is 1,250,000 kg/year divided by 250 days/year or 5,000 kg/day. Thirty percent of this amount, or 1,500 kg/day, is extruded in a process using contact cooling water; 3,500 kg/day is injection molded; and the injection molds in which 3,500 kg/day of plastic material are molded are washed. Of the injection molded parts, 1,750 kg/day are trimmed in a finishing process.

Plant X processes 5,000 kg/day of polyethylene in a pelletizing process using contact cooling water and 1,500 kg/day of polyethylene in an extrusion process using contact cooling and heating water. These processes are regulated under the contact cooling and heating water subcategory. The "average process water usage flow rate" of contact cooling and heating water for this plant is 65 gpm for the pelletizing process plus 20 gpm for the extrusion process. Thus, the effluent limitations guidelines for processes with an "average process water usage flow rate" greater than 35 gpm apply.

Plant X cleans injection molds with process water; 3,500 kg/day of polyethylene are shaped by these molds. This process is regulated under cleaning in the cleaning and finishing water subcategory. Plant X trims 1,750 kg/day of polyethylene in a process using process water. This process is regulated under finishing in the cleaning and finishing water subcategory. Table X-4 illustrates the calculation of the allowable discharge of BOD_5 for this plant.

Table X-4

ALLOWABLE DISCHARGE OF BOD_5 FOR PLANT X

Process Water	Average Daily Production (kg/day)	One-Day Maximum Mass (mg/kg)*	Monthly Average Mass (mg/kg)*	Allowable One-Day Maximum Mass (mg/day)	Allowable Monthly Average Mass (mg/day)
Contact Cooling Water for Pelletizing	5,000	78	35	390,000	175,000
Contact Cooling Water for Extrusion	1,500	78	35	117,000	52,500
Cleaning Water for Injection Molds	3,500	220	99	770,000	346,500
Finishing Water for Trimming	1,750	52	23	91,000	40,250
				1,368,000**	614,250**

*These values are the BPT effluent limitations guidelines for BOD_5.

**BOD_5 effluent concentration (mg/l) can be calculated by dividing these values by the plant's daily process water discharge (liters/day).

SECTION XI

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

The factors considered in assessing best available technology economically achievable (BAT) include the age of equipment and facilities involved, the process employed, process changes, non-water quality environmental impacts (including energy requirements) and the costs of applying such technology (Section 304(b)(2)(B) of the Clean Water Act). At a minimum, the BAT technology level represents the best economically achievable performance of plants of various ages, sizes, processes, or other shared characteristics. As with BPT, where the Agency has found the existing performance to be uniformly inadequate, BAT may be transferred from a different subcategory or category. BAT may include feasible process changes or internal controls even when not common industry practice.

The required assessment of BAT "considers" costs, but does not require a balancing of costs against effluent reduction benefits (See, Weyerhaeuser v. Costle, supra). In developing BAT, however, EPA gave substantial weight to the reasonableness of cost. The Agency considers the volume and nature of discharges expected after application of BPT, the general environmental effects of the pollutants, and the costs and economic impacts of the additional pollution control levels.

Despite this expanded consideration of costs, the primary determinant of BAT is effluent reduction capability. As a result of the Clean Water Act of 1977, the achievement of BAT has become the principal national means of controlling toxic pollutants. The wastewaters generated by PM&F processes contain 28 priority toxic pollutants that were considered for control including eight toxic metals and 20 toxic organics.

Contact Cooling and Heating Water Subcategory

The Agency considered two technology options as the basis for the proposed BAT effluent limitations guidelines. These options, which are the same as BPT Option 2 and BPT Option 3 for this subcategory, are:

Option 1:

For processes with an average process water usage flow rate of 35 gpm or less - Zero discharge by 100 percent recycle of the process water using either a tank or chiller.

For processes with an average process water usage flow rate greater than 35 gpm - Recycle through a cooling tower and treatment of the recycle unit discharge in a package activated sludge plant. An equalization tank is included as part of the package plant.

Option 2:

For processes with an average process water usage flow rate of 35 gpm or less - Zero discharge by 100 percent recycle of the wastewater through either a tank or chiller.

For processes with an average process water usage flow rate greater than 35 gpm - Recycle through a cooling tower and zero discharge by contract haul of the discharge from the recycle unit.

The Agency is not proposing BAT effluent limitations guidelines more stringent than the proposed BPT effluent limitations guidelines for this subcategory because there are insignificant quantities of toxic pollutants remaining in contact cooling and heating water after compliance with the applicable BPT effluent limitations guidelines. As previously discussed, the proposed BPT model technology (BPT Option 2) achieves significant removal of toxic pollutants present in contact cooling and heating water. Of the estimated 124,000 kilograms per year of toxic pollutants currently discharged by direct dischargers in this subcategory, 99,000 kilograms per year of these pollutants will be removed by compliance with the proposed BPT effluent limitations guidelines. Thus, 25,000 kilograms per year of toxic pollutants will be discharged after application of the BPT effluent limitations guidelines. This discharge equates to approximately 0.20 kilograms per day of toxic pollutants per direct discharger in this subcategory. Table XI-1 lists the estimated amount of the 26 toxic pollutants found in contact cooling and heating water that would be discharged per year by direct dischargers in this subcategory after BPT treatment. Also shown on that table are the average concentrations of the toxic pollutants in wastewater after BPT treatment. The Agency believes that the amount and toxicity of these pollutants do not justify establishing more stringent BAT effluent limitations guidelines for the toxic pollutants. Accordingly, EPA is proposing to exclude these pollutants from further national regulation under Paragraph 8(a)(i) of the Settlement Agreement in NRDC v. Train, supra.

EPA estimates that 79 percent of the projected 27,243,000 kilograms per year of nonconventional pollutants in contact cooling and heating water will be removed when plants in the PM&F category comply with the BPT effluent limitations guidelines. The remaining amount of nonconventional pollutants results in a

Table XI-1

AMOUNT AND CONCENTRATION OF TOXIC POLLUTANTS IN WASTEWATER AFTER BPT TREATMENT

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutant		Estimated Amount Remaining After BPT Treatment (kg/yr)	Average Concentration After BPT Treatment (mg/l)
4.	benzene	850	0.010
6.	carbon tetrachloride (tetrachloromethane)	9,300	0.318
11.	1,1,1-trichloroethane	950	0.010
22.	parachlorometa cresol	691	0.025
23.	chloroform (trichloromethane)	280	0.010
44.	methylene chloride (dichloromethane)	390	0.010
65.	phenol	73	0.025
66.	bis(2-ethylhexyl) phthalate	10,320	0.200
68.	di-n-butyl phthalate	610	0.010
85.	tetrachloroethylene	1.1	0.010
86.	toluene	37	0.010
89.	aldrin	6.8	0.252*
90.	dieldrin	2.3	0.041*
93.	4,4'-DDE	0.07	0.044*
100.	heptachlor	0.9	0.030*
102.	α-BHC	4	0.056*
103.	β-BHC	1.7	0.176*
104.	γ-BHC	0.95	0.074*
105.	δ-BHC	3.6	0.050*
118.	cadmium	16	0.004
119.	chromium (Total)	60	0.012
120.	copper	23	0.041
122.	lead	230	0.042
123.	mercury	0.005	0.0001
124.	nickel	158	0.446
128.	zinc	460	0.044

*ug/l

discharge of approximately 48 kilograms per day per direct discharger in this subcategory. The impact of this amount is not known. Therefore, EPA will investigate the nonconventional pollutants, particularly TOC and COD, between this proposal and promulgation of the PM&F regulation to determine what contributes to those pollutants (e.g., a toxic pollutant). Additional controls may be imposed for the nonconventional pollutants depending on the results of that investigation.

As previously discussed, the 35 gpm cut-off for the selected BPT/BAT option is the average flow rate of the eight processes with the best flow rates that recycle 100 percent of the process water using a chiller. Information obtained from the questionnaire surveys for this project indicate that processes with flow rates as high as 500 gpm can recycle 100 percent of the process water using a chiller. The Agency will evaluate that information further to see if the 35 gpm cut-off should be higher under BAT when the final regulation is promulgated.

Cleaning and Finishing Water Subcategory

The Agency considered two technology options for the basis for the BAT effluent limitations guidelines for this subcategory. These options, which are the same as BPT Option 2 and BPT Option 3 for this subcategory, are:

Option 1:

This option consists of recycle through a sedimentation tank and treatment of the discharge from the recycle unit in a package activated sludge plant. The package plant includes an equalization unit and pH adjustment. A sedimentation tank is used to remove the suspended solids in the wastewater so that the wastewater can be recycled.

Option 2:

Option 2 consists of recycle through a sedimentation tank for all processes and contract haul of the discharge from the recycle unit.

The Agency is not proposing BAT effluent limitations guidelines more stringent than the proposed BPT effluent limitations guidelines for this subcategory because there are insignificant quantities of priority toxic pollutants remaining in cleaning and finishing water after compliance with the proposed applicable BPT effluent limitations guidelines. The Agency estimates that compliance with the BPT effluent limitations guidelines results in the removal of 786 kilograms per year of toxic pollutants from the current discharge of 890 kilograms per year toxic pollutants by plants in this subcategory. Thus, 104 kilograms per year of toxic pollutants would be discharged after application of the proposed BPT effluent limitations guidelines. This equates to less than 0.01 kilograms per day of toxic pollutants per direct discharger. Table XI-2 lists the estimated amount of the 17 toxic pollutants found in cleaning and finishing water that would be discharged per year by direct dischargers in this subcategory after BPT treatment. Also shown on the table is the average concentration of the toxic pollutants after BPT treatment. The Agency has determined that the amount and toxicity of these pollutants do not justify establishing more stringent BAT effluent limitations guidelines for toxic pollutants. Accordingly, EPA is proposing to exclude these pollutants from further national regulation under Paragraph 8(a)(i) of the Settlement Agreement in *NRDC* v. *Train*, *supra*.

EPA estimates that 86 percent of the 939,200 kilograms per year of nonconventional pollutants in cleaning and finishing water will be removed when plants comply with the BPT effluent limitations guidelines. The remaining amount of nonconventional pollutants result in a discharge of approximately one kilogram per day per direct discharger in this subcategory. The Agency will investigate what contributes to the nonconventional pollutants to determine if additional controls for these pollutants are needed when the final BAT effluent limitations guidelines are promulgated.

Table XI-2

AMOUNT AND CONCENTRATION OF TOXIC POLLUTANTS AFTER BPT TREATMENT

CLEANING AND FINISHING WATER SUBCATEGORY

Priority Pollutant	Amount Remaining After BPT Treatment (kg/yr)	Average Concentration After BPT Treatment (mg/l)
4. benzene	0.20	0.01
23. chloroform (trichloromethane)	4	0.01
44. methylene chloride (dichloromethane)	40	0.01
62. N-nitrosodiphenylamine	4	0.01
65. phenol	1	0.025
66. bis(2-ethylhexyl) phthalate	10	0.059
86. toluene	0.14	0.010
89. aldrin	0.14	0.041*
100. heptachlor	<0.01	0.003*
102. α-BHC	<0.01	0.002*
104. γ-BHC	0.10	0.300*
105. δ-BHC	0.12	0.052*
119. chromium (Total)	2.3	0.007
120. copper	3	0.024
124. nickel	6.5	0.034
125. selenium	0.38	0.075
128. zinc	32	0.380

*ug/l

SECTION XII

NEW SOURCE PERFORMANCE STANDARDS

The basis for new source performance standards (NSPS) under Section 306 of the Act is the best available demonstrated technology. New plants have the opportunity to design and use the best and most efficient plastics molding and forming processes and wastewater treatment technologies without facing the added costs and restrictions encountered in retrofitting an existing plant. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible when developing NSPS.

TECHNICAL APPROACH TO NSPS

The Agency believes that characteristics of wastewater discharged by new PM&F processes in each subcategory will be the same as the characteristics of wastewater discharged by existing PM&F processes in those subcategories. Thus, the treatment options considered for new sources in each subcategory are the same as those considered for existing sources. These options are outlined in the BPT section of this development document.

NSPS OPTION SELECTION

The Agency is proposing NSPS based on the same model treatment technologies as the proposed BPT effluent limitations guidelines in each subcategory (BPT Option 2). EPA is not proposing NSPS more stringent than the effluent limitations guidelines for existing sources because the amount and toxicity of the priority toxic pollutants remaining after treatment in the BPT/BAT model treatment technologies for each subcategory do not justify more stringent controls. See Tables XI-1 and XI-2 in the BAT section of this development document. The proposed NSPS technology basis for each subcategory are:

Contact Cooling and Heating Water Subcategory

For processes in the contact cooling and heating water subcategory with an average process water usage flow rate of 35 gpm or less the technology basis of NSPS is zero discharge. For processes with an average process water usage flow rate equal to or less than 0.3 gpm, zero discharge is achieved with a product quench tank of proper surface area to allow for sufficient heat transfer to the surrounding environment. For processes with an average process water usage flow rate for flows greater than 0.3 gpm and less than or equal to 35 gpm, the zero discharge technology basis is a chiller system with 100 percent recycle. The chiller recycle system is depicted in Figure XII-1.

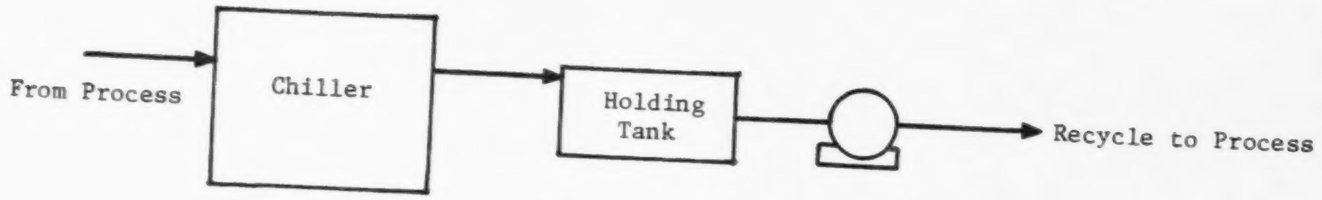

Figure XII-1

CHILLER RECYCLE UNIT USED TO ACHIEVE 100 PERCENT RECYCLE - NSPS CONTACT COOLING AND HEATING WATER SUBCATEGORY

For flows above 35 gpm, the technology basis of NSPS is a recycle through a cooling tower and treatment of the recycle unit discharge in an end-of-pipe treatment system consisting of equalization followed by a package activated sludge plant. Figure XII-2 illustrates this technology.

The 35 gpm cut-off was used for NSPS for the same reasons it was used for the BPT/BAT technology options. As discussed in Section XI, the Agency will consider using a higher flow cut because information from the questionnaire surveys indicates that the recycle unit used to achieve 100 percent of the process water may be used for flows up to 500 gpm.

Cleaning and Finishing Water Subcategory

The NSPS technology basis for the cleaning and finishing water subcategory consists of a recycle through a sedimentation tank to remove solids and floatable material. Sludge and scum that accumulate in the tank are removed periodically by a contract hauler. Recycle unit discharge flows to an equalization tank where pH of the wastewater is controlled and is then treated in a package activated sludge plant. A schematic of the NSPS technology for the cleaning and finishing water subcategory is presented in Figure XII-3.

Costs and Pollutant Removals for NSPS

The Agency conducted an economic analysis of the impact of the proposed NSPS on new PM&F plants. The analysis was based on a normal plant that contains four model processes. Each model process represents one of the four segments of the category for which technology options were developed. The model processes consist of two processes that use contact cooling and heating water and two processes that use cleaning and finishing water. Two model processes were developed for the contact cooling and heating water subcategory because that subcategory was subdivided based on average process water usage flow rate (i.e., a 35 gpm cut-off was used). Two model processes were developed for the cleaning and finishing water subcategory because, as discussed in Section IX, a cut-off of two gpm was used in this subcategory for costing purposes. Even though the technology basis for NSPS for all processes in the cleaning and finishing water subcategory is flow reduction and treatment of the discharge from the recycle unit, the technology basis for costing purposes for processes with an average process water usage flow rate of two gpm or less is flow reduction and contract haul of the recycle unit discharge. This technology was costed for the low flow rate processes because it is more economical than treatment of the recycle unit discharge. The Agency believes that plastic molders and formers will comply with the BPT effluent limitations guidelines in the least costly way.

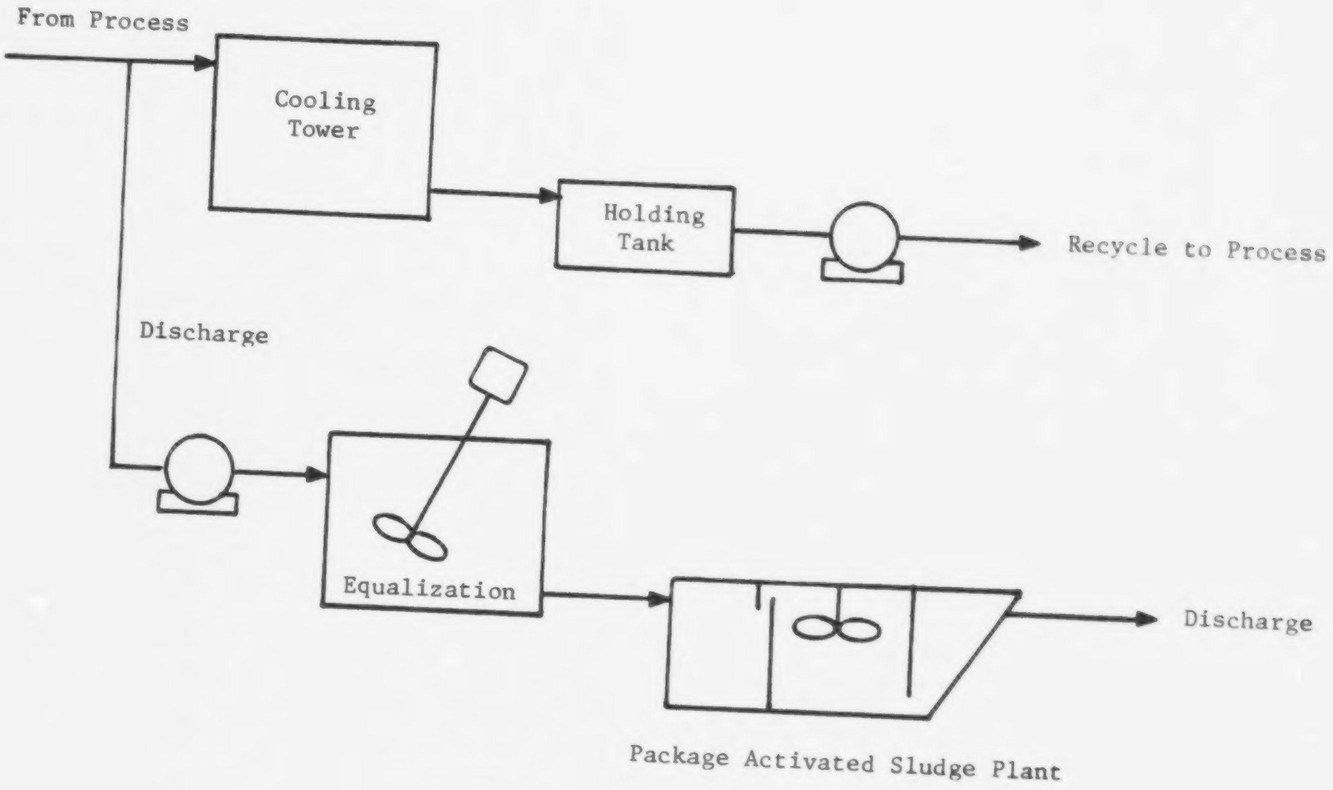

Figure XII-2

NSPS TECHNOLOGY BASIS FOR PROCESSES WITH A PROCESS WATER USAGE FLOW RATE GREATER THAN 35 GPM
CONTACT COOLING AND HEATING WATER SUBCATEGORY

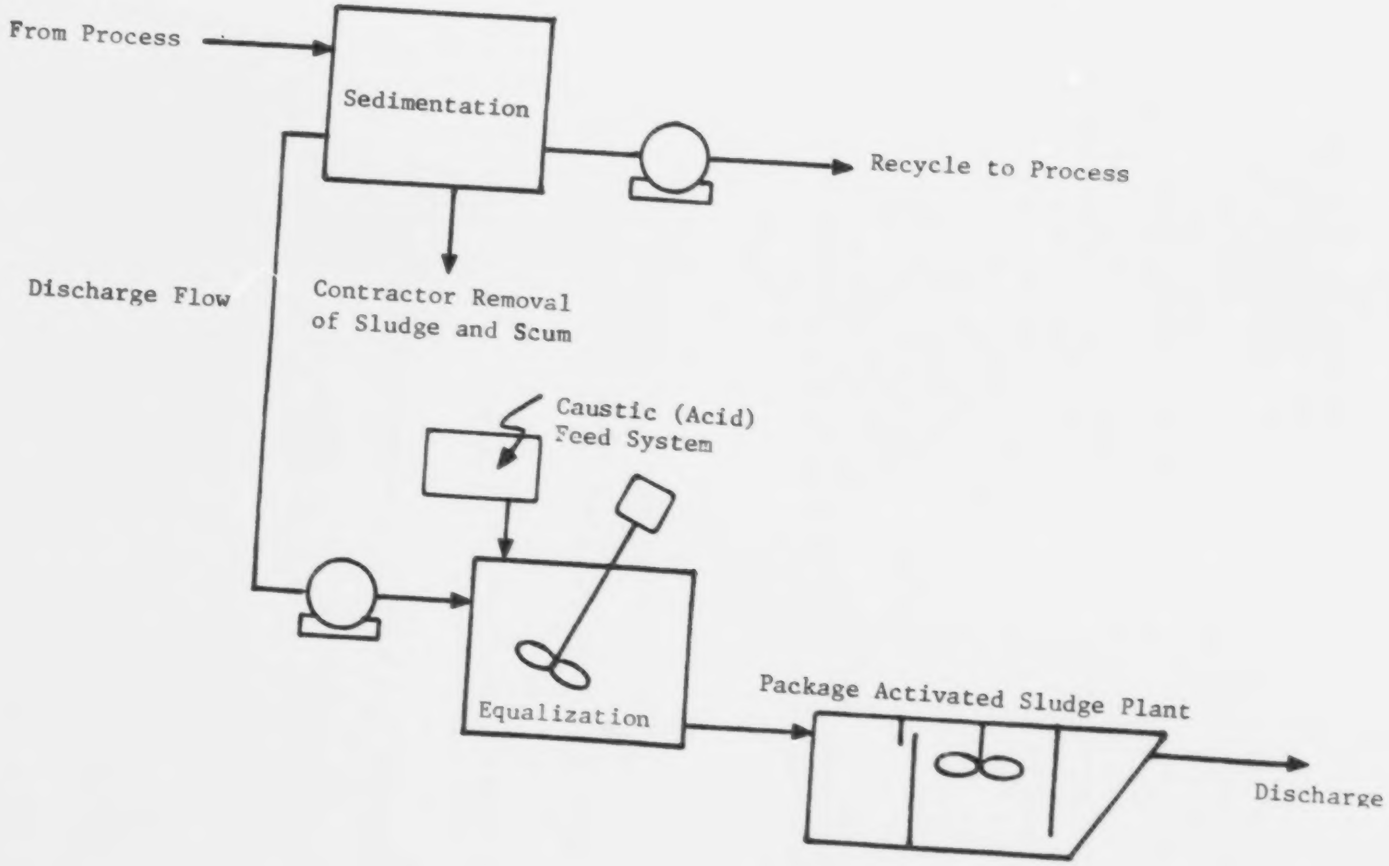
From Process
Sedimentation
Recycle to Process
Discharge Flow
Contractor Removal of Sludge and Scum
Caustic (Acid) Feed System
Equalization
Package Activated Sludge Plant
Discharge

Figure XII-3

NSPS TECHNOLOGY
CLEANING AND FINISHING WATER SUBCATEGORY

Thus, four model processes were chosen: one contact cooling and heating water process with an average process water usage flow rate greater than 35 gpm, one contact cooling and heating water process with an average process water usage flow rate less than 35 gpm, one cleaning and finishing water process with an average process water usage flow rate greater than two gpm, and one cleaning and finishing water process with an average process water usage flow rate less than two gpm. The actual flow rates associated with the model processes are based on the median flow rates of processes in the questionnaire data base. Those median flow rates are presented in Table XII-1. The NSPS technology for contact cooling and heating water processes with an average process water usage flow rate of 35 gpm or less is depicted in Figure XII-1; the technology for contact cooling and heating water processes with a process water usage flow rate greater than 35 gpm is depicted in Figure XII-2. Figure XII-3 depicts the NSPS technology for the cleaning and finishing water processes with an average process water usage flow rate greater than two gpm. These technologies are the same as the technologies for existing sources.

Table XII-1

FLOW RATES FOR NSPS MODEL PROCESSES

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Model Process #1 (flows ≤35 gpm)	13 gpm
Model Process #2 (flows >35 gpm)	90 gpm

CLEANING AND FINISHING WATER SUBCATEGORY

Model Process #3 (flows ≤2 gpm)	0.8 gpm
Model Process #4 (flows >2 gpm)	16 gpm

The amount of pollutants in the raw wastewater of the model processes are shown in Table XII-2. The pollutant removals for the proposed NSPS technology for each of the model processes are presented in Table XII-3. Data for existing sources were used to estimate the percent removals.

Table XII-2

POLLUTANT MASS IN RAW WASTE FOR NSPS MODEL PROCESSES (kg/yr)

Pollutant	Contact Cooling and Heating Water Subcategory		Cleaning and Finishing Water Subcategory	
	Model Process #1	Model Process #2	Model Process #3	Model Process #4
Conventional	18,800	30,100	3,060	21,500
Nonconventional	57,400	91,900	4,040	28,400
Priority Toxic	261	418	4	27

Table XII-3

ESTIMATED POLLUTANT REMOVALS FOR NSPS MODEL PROCESSES (kg/yr)

Pollutant	Contact Cooling and Heating Water Subcategory		Cleaning and Finishing Water Subcategory	
	Model Process #1	Model Process #2	Model Process #3	Model Process #4
Conventional	18,800	24,000	3,060	19,700
Nonconventional	57,400	58,100	4,040	23,800
Priority Toxic	261	273	4	23

The estimated investment cost and annual pollution control costs for the proposed NSPS technology for each of the model processes are presented in Table XII-4. The average investment costs for the normal plant is $26,070 and the average annual pollution control costs for the normal plant is $10,900.

Table XII-4

NSPS TREATMENT TECHNOLOGY COSTS PER MODEL PROCESSES
($ Million, 1982 Dollars)

	Contact Cooling and Heating Water Subcategory		Cleaning and Finishing Water Subcategory	
	Model Process #1	Model Process #2	Model Process #3	Model Process #4
Investment Cost	$10,200	$52,500	$4,070	$37,500
Annual Pollution Control Costs	$ 3,840	$20,072	$3,702	$15,971

The data relied on for the economic analysis of NSPS were primarily the data developed for existing sources, which includes costs on a plant-by-plant basis along with retrofit costs where applicable. The Agency believes that compliance costs could be lower for new sources than costs for equivalent existing sources because production processes can be designed to reduce the amount of wastewater discharged and there would be no costs associated with retrofitting a process. The Agency does not believe that applying the proposed technology for NSPS to new sources, including major modifications to existing sources, creates a barrier to entry into the category because new sources will expend an amount equal to, or possibly less than, the amount required by existing sources to comply with this proposed regulation.

REGULATED POLLUTANTS AND POLLUTANT PROPERTIES

The Agency has no reason to believe that the pollutants that will be found in significant quantities in PM&F wastewater from new sources will be any different than pollutants found in wastewater from existing sources. Consequently, pollutants selected for regulation under NSPS are the pollutants controlled at BPT for each subcategory. They are: biochemical oxygen demand, total suspended solids, oil and grease, and pH. Mass based NSPS are being proposed for the same reasons that the BPT effluent limitations guidelines are mass based (see Section X). The Agency estimates that 79 percent of the nonconventional pollutants and 80 percent the toxic pollutants are removed when the NSPS for the above pollutants are met.

NEW SOURCE PERFORMANCE STANDARDS

The regulatory production normalized flows and the activated sludge effluent concentration values used to calculate NSPS are the same as those used at BPT for each subcategory. These effluent concentration values and production normalized flows for each subcategory are discussed in more detail in Section X of this development document.

NSPS were calculated by multiplying the NSPS regulatory production normalized flow by the NSPS technology effluent concentration values.

Contact Cooling and Heating Water Subcategory

The effluent limitations guidelines and standards for this subcategory are the mass of pollutant that may be discharged per unit mass of plastic material processed by processes in the contact cooling and heating water subcategory. Processes in the contact cooling and heating water subcategory are processes in which water contacts the plastic material for the purpose of heat transfer. A discharge allowance is given each time water is used for cooling or heating in a process. For example, if one unit mass of plastic is extruded and then molded, and cooling water is used in each process, the discharge allowance for a pollutant would be based on the amount of plastic material processed in both processes.

Average Process Water Usage Flow Rate of 35 gpm or Less. For processes with an average process water usage flow rate of 35 gpm or less, the regulatory production normalized flow is zero discharge. Therefore, no wastewater pollutants shall be discharged from these processes.

Average Process Water Usage Flow Rate Greater Than 35 gpm. For processes with an average process water usage flow rate greater than 35 gpm, NSPS are:

Contact Cooling and Heating Water

Regulated Pollutant or Pollutant Property	NSPS Maximum For Any One Day (mg/kg)	NSPS Maximum For Monthly Average (mg/kg)
BOD_5	78	35
Oil and Grease	113	27
TSS	186	57
pH	(1)	(1)

(1) Between 6.0 and 9.0.

The "average process water usage flow rate" of a process in gallons per minute is equal to the volume of process water (gallons) used per year by a process divided by the total time (minutes) per year the process operates. The "average process water usage flow rate" for a plant with more than one plastics molding and forming process that uses contact cooling and heating water is the sum of the "average process water usage flow rates" for those plastics molding and forming processes. The "volume of process water used per year" is the volume of process water that flows through a process and comes in contact with the plastic product over a period of one year.

Cleaning and Finishing Water Subcategory

The NSPS for this subcategory are the mass of pollutant that may be discharged per unit mass of plastic material processed by processes in the cleaning and finishing water subcategory. Processes in the cleaning and finishing water subcategory are processes that use process water to clean or finish plastic material or processes that use process water to clean the surfaces of product shaping equipment, such as molds and mandrels, that contacted the plastic product. The mass of plastic material processed by processes that use process water to clean or finish plastic products is defined as the mass of plastic material cleaned or finished. The mass of plastic material processed by processes that use process water to clean shaping equipment is defined as the mass of plastic that is processed in the shaping equipment.

A discharge allowance is given each time water is used for cleaning or finishing in a distinct processing step. For example, if one unit mass of plastic is washed with water and then polished in a finishing process that uses process water, a discharge allowance would be given for each process. Washing and then rinsing is considered a single process step. Only one discharge allowance is given for the wash and rinse operation.

Cleaning Water. Cleaning water is process water used to clean an intermediate or final plastic product or to clean the surfaces of product shaping equipment, such as molds and mandrels, that contacted the plastic product. It includes water used in both the detergent wash and rinse cycles of a cleaning process.

The mass of pollutants that can be discharged by PM&F processes at new sources that use cleaning water is:

Cleaning Water

Regulated Pollutant or Pollutant Property	NSPS Maximum For Any One Day (mg/kg)	NSPS Maximum For Monthly Average (mg/kg)
BOD_5	220	99
Oil and Grease	318	76
TSS	524	161
pH	(1)	(1)

(1) Between 6.0 and 9.0.

Finishing Water. Finishing water is process water used to remove waste plastic material generated during a finishing process or to lubricate a plastic product during a finishing process. It includes water used to machine, to decorate, or to assemble intermediate or final plastic products.

The mass of pollutants that can be discharged by PM&F processes at new sources that use finishing water is:

Finishing Water

Regulated Pollutant or Pollutant Property	NSPS Maximum For Any One Day (mg/kg)	NSPS Maximum For Monthly Average (mg/kg)
BOD_5	52	23
Oil and Grease	76	18
TSS	125	38
pH	(1)	(1)

(1) Between 6.0 and 9.0.

SECTION XIII

PRETREATMENT STANDARDS

Section 307(b) of the Clean Water Act requires EPA to consider pretreatment standards for existing sources (PSES) to be achieved within three years of promulgation. PSES are designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of publicly owned treatment works (POTW). Congress directed that pretreatment standards be technology based, analogous to the best available technology for removal of toxic pollutants.

Section 307(c) of the Act requires EPA to consider whether to establish pretreatment standards for new sources (PSNS) at the same time that it establishes new source performance standards for new direct dischargers. New indirect discharge facilities, like new direct discharge facilities, have the opportunity to incorporate the best available demonstrated technologies, including process changes, in-plant controls, and end-of-pipe treatment technologies, and to use plant site selection to ensure adequate treatment system installation.

General Pretreatment Regulations for existing and new sources were published in the Federal Register (Vol. 43, No. 123; June 26, 1978). These regulations (40 CFR Part 403) describe the Agency's overall policy for establishing and enforcing categorical pretreatment standards for new and existing industrial users of a POTW and delineate the responsibilities and deadlines applicable to each party in this effort. In addition, Section 403.5(b) of 40 CFR Part 403 lists prohibited discharges that apply to all users of a POTW.

Before proposing categorical pretreatment standards, the Agency examines whether the toxic pollutants discharged by an industry pass through the POTW or interfere with the POTW operation or its chosen sludge disposal practices. In determining whether pollutants pass through a POTW, the Agency compares the percentage of a pollutant removed by POTWs to the percentage removed by direct dischargers applying the best available technology economically achievable. A pollutant is deemed to pass through the POTW when the average percentage removed by well-operated POTWs meeting secondary treatment requirements is less than the percentage removed by direct dischargers complying with BAT effluent limitation guidelines for that pollutant. For this category where the Agency is proposing BAT equal to BPT, the Agency compared POTW removals to BPT level removals.

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This definition of pass through satisfies two competing objectives set by Congress: (1) that standards for indirect dischargers be equivalent to standards for direct dischargers, while, at the same time, (2) that the treatment capability and performance of the POTW be recognized and taken into account in regulating the discharge of pollutants from indirect dischargers.

PRETREATMENT STANDARDS FOR EXISTING SOURCES

Contact Cooling and Heating Water Subcategory

BPT/BAT effluent limitations guidelines for PM&F processes in the contact cooling and heating water subcategory with an average process water usage flow rate greater than 35 gpm are based on treatment in the activated sludge process. The Agency reviewed performance data for that process and compared it to the performance data of well operated publicly owned treatment works. The comparison of activated sludge treatment performance to POTW performance for contact cooling and heating water is shown in Table XIII-1.

The sources of the performance data are referenced in the table. Pass through occurs when the percent removal of a pollutant in the BPT/BAT is greater than the percent removal in the POTW. As can be seen from the data in the table, chloroform and methylene chloride may pass through a POTW. However, the amount and toxicity of these pollutants is such that the Agency does not believe that additional pretreatment is necessary for the reduction of these pollutants prior to indirect discharge. EPA estimates that the amount of chloroform in contact cooling and heating water discharged by indirect dischargers is 0.032 kg/plant per day. The amount of methylene chloride discharged in contact cooling and heating water is 0.037 kg/plant per day.

EPA believes that the methylene chloride concentration reported for contact cooling and heating water is the result of laboratory contamination. Methylene chloride is used in the laboratory to prepare sample bottles, as a solvent in some extraction procedures, and for other purposes. Therefore, the potential for a sample to be contaminated in the laboratory with methylene chloride is high. This high contamination potential supports EPA's belief that methylene chloride is not in the process water and that a categorical pretreatment standard is not needed to control methylene chloride.

No performance data for either activated sludge treatment or treatment in a POTW are available for dieldrin, 4,4'-DDE, and β-BHC. However, the amount and toxicity of these pollutants in the PM&F wastewater do not warrant categorical pretreatment standards for those pollutants. The amount of dieldrin,

Table XIII-1

COMPARISON OF BPT/BAT POLLUTANT REMOVALS TO POTW POLLUTANT REMOVALS CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutant	BPT/BAT Percent Removal	Source	POTW Percent Removal	Source
4. benzene	66	1	99	3
6. carbon tetrachloride (tetrachloromethane)	73	2	73	2
11. 1,1,1-trichloroethane	73	1	94	3
22. parachlorometa cresol	40	1	88	2
23. chloroform (trichloromethane)	90	1	62	3
44. methylene chloride (dichloromethane)	88	1	56	3
65. phenol	92	1	99	3
66. bis(2-ethylhexyl) phthalate	40	4	58	3
68. di-n-butyl phthalate	17	1	51	3
85. tetrachloroethylene	67	1	85	3
86. toluene	38	1	96	3
89. aldrin	20	2	20	2
90. dieldrin	No Data		No Data	
93. 4,4'-DDE	No Data		No Data	
100. heptachlor	85	2	85	2
102. α-BHC	77	2	77	2
103. β-BHC	No Data		No Data	
104. γ-BHC	44	2	44	2
105. δ-BHC	52	2	52	2
118. cadmium	83	1	93	3
119. chromium (Total)	76	3	76	3
120. copper	82	3	82	3
122. lead	83	1	97	3
123. mercury	75	1	85	3
124. nickel	35	3	35	3
128. zinc	77	3	77	3

Sources:

1. Percent removal is based on the analytical detection limit. See Appendix C.
2. Average of data available from Fate of Priority Pollutants in Publicly Owned Treatment Works, Final Report, Volume I, EPA-440/1-82/303, September 1982.
3. Table 10, Fate of Priority Pollutants in Publicly Owned Treatment Works, Final Report, Volume 1, EPA-440/1-82/303, September 1982.
4. Based on treatability limits presented in "Contractors Engineering Report, Analysis of Organic Chemicals and Plastics/Synthetic Fiber Industries, Toxic Pollutants." See Appendix C.

4,4'-DDE, and β-BHC in contact cooling and heating water discharged to a POTW are 0.03, 0.0009, 0.02 grams per plant per day, respectively.

The BPT/BAT effluent limitations guidelines for processes in the contact cooling and heating water subcategory with an average process water usage flow rate of 35 gpm or less are based on zero discharge by 100 percent recycle. Based on a comparison of the average percentage removal of priority pollutants by well operated POTWs meeting secondary treatment requirements to the 100 percent removal of pollutants in the BPT/BAT technology, the priority pollutants pass through a POTW. However, the amount of pollutants discharged per day per indirect discharger in the contact cooling and heating water subcategory with an average process water usage flow rate of 35 gpm or less is estimated to be 0.6 kilogram per day. Table XIII-2 contains a distribution of this mass by individual pollutant. The Agency believes that the amount and toxicity of the priority pollutants discharged by those processes do not justify the development of PSES for this segment of the PM&F category. Accordingly, PSES for this segment of the contact cooling and heating water subcategory are not being developed for those pollutants based on Paragraph 8(a)(iv) of the Settlement Agreement in *NRDC* v. *Train*, *supra*. PSES are also not being developed for chloroform, methylene chloride, dieldrin, 4,4'-DDE, and β-BHC for this subcategory based on Paragraph 8(a)(iv).

Cleaning and Finishing Water Subcategory

BPT/BAT effluent limitations guidelines for PM&F processes in the cleaning and finishing water subcategory are based on treatment in an activated sludge process. The Agency reviewed performance data for the activated sludge process and compared it to the performance data of well operated publicly owned treatment works. That comparison is shown in Table XIII-3. The sources of the performance data are referenced in the table.

As can be seen from the data in the table, only chloroform and methylene chloride pass through a POTW. However, the amount and toxicity of these pollutants do not justify categorical pretreatment standards for these pollutants. EPA estimates that the amount of chloroform in cleaning and finishing water discharged to a POTW is 0.0008 kg/plant per day; the quantity of methylene chloride in cleaning and finishing water discharged to a POTW is 0.01 kg/plant per day. EPA also believes that methylene chloride is present in cleaning and finishing water because of laboratory contamination of the samples.

Performance data are not available for the removal of N-nitrosodiphenylamine in a POTW. However, the Agency believes that the

Table XIII-2

ESTIMATED MASS OF POLLUTANTS DISCHARGED BY INDIRECT DISCHARGING PROCESSES WITH AN AVERAGE PROCESS WATER USAGE FLOW RATE OF 35 GPM OR LESS CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutant		Amount Discharged (kg/day per plant)
4.	benzene	0.020
6.	carbon tetrachloride (tetrachloromethane)	0.270
11.	1,1,1-trichloroethane	0.028
22.	parachlorometa cresol	0.008
23.	chloroform (trichloromethane)	0.022
44.	methylene chloride (dichloromethane)	0.026
65.	phenol	0.007
66.	bis(2-ethylhexyl) phthalate	0.137
68.	di-n-butyl phthalate	0.006
85.	tetrachloroethylene	<0.001
86.	toluene	<0.001
89.	aldrin	<0.001
90.	dieldrin	<0.001
93.	4,4'-DDE	<0.001
100.	heptachlor	<0.001
102.	α-BHC	<0.001
103.	β-BHC	<0.001
104.	γ-BHC	<0.001
105.	δ-BHC	<0.001
118.	cadmium	<0.001
119.	chromium (Total)	0.002
120.	copper	0.001
122.	lead	0.011
123.	mercury	<0.001
124.	nickel	0.002
128.	zinc	0.016
	TOTAL	0.556

Table XIII-3

COMPARISON OF BPT/BAT POLLUTANT REMOVALS TO POTW POLLUTANT REMOVALS
CLEANING AND FINISHING WATER SUBCATEGORY

Priority Pollutant	BPT/BAT Percent Removal	Source	POTW Percent Removal	Source
4. benzene	62	1	99	3
23. chloroform (trichloromethane)	78	1	62	3
44. methylene chloride (dichloromethane)	85	1	56	3
62. N-nitrosodiphenylamine	72	1	No Data	3
65. phenol	98	1	99	3
66. bis(2-ethylhexyl) phthalate	0	4	58	3
86. toluene	92	1	96	3
89. aldrin	20	2	20	2
100. heptachlor	85	2	85	2
102. α-BHC	60	1	77	2
104. γ-BHC	44	2	44	2
105. δ-BHC	55	2	55	2
119. chromium (Total)	74	1	76	3
120. copper	82	3	82	3
124. nickel	35	3	35	3
125. selenium	37	2	37	2
128. zinc	77	3	77	3

Sources:

1. Percent removal is based on the analytical detection limit. See Appendix C.
2. Average of data available from Fate of Priority Pollutants in Publicly Owned Treatment Works, Final Report, Volume I, EPA-440/1-82/303, September 1982.
3. Table 10, Fate of Priority Pollutants in Publicly Owned Treatment Works, Final Report, Volume 1, EPA-440/1-82/303, September 1982.
4. Based on treatability limits presented in "Contractors Engineering Report, Analysis of Organic Chemicals and Plastics/Synthetic Fiber Industries, Toxic Pollutants." See Appendix C.

amount and toxicity of this pollutant do not warrant a categorical pretreatment standard. The amount of N-nitrosodiphenylamine in cleaning and finishing water discharged to a POTW is 0.0005 kg/plant per day.

PSES are not being developed for chloroform, methylene chloride, and N-nitrosodiphenylamine for this subcategory based on Paragraph 8(a)(iv) of the Settlement Agreement in NRDC v. Train, supra.

Proposed PSES

The Agency proposes no categorical pretreatment standards for either the contact cooling and heating water subcategory or the cleaning and finishing water subcategory. Even though no pretreatment standards are being proposed, existing indirect dischargers in both subcategories must comply with the General Pretreatment Regulations (40 CFR Part 403).

PRETREATMENT STANDARDS FOR NEW SOURCES

The Agency is not proposing PSNS for this category because the pollutants for this category either do not pass through a POTW or the amount and toxicity of the pollutants discharged to a POTW do not justify establishing PSNS. The Agency believes that new and existing indirect discharge sources will discharge the same pollutants in similar amounts. The average percentage removal of toxic pollutants by well operated POTWs meeting secondary treatment requirements (i.e., 64 percent) is slightly greater than the percentage removed (i.e., 62 percent) by a direct discharger in the cleaning and finishing subcategory and by direct dischargers with an average process water usage flow rate greater than 35 gpm in the contact cooling and heating water subcategory when in compliance with NSPS (which are equivalent to the BPT/BAT effluent limitations guidelines). In addition, even though some toxic pollutants discharged by plants with processes in the contact cooling and heating water subcategory with average process water usage flow rates of 35 gpm or less may pass through, the amount and toxicity discharged to POTWs (0.6 kilograms per discharger per day) do not justify establishing PSNS. Also, the amount and toxicity of the pollutants in wastewater discharged by processes in the contact cooling and heating water subcategory with an average process water usage flow rate greater than 35 gpm and in cleaning and finishing process wastewater do not justify establishing PSNS for those pollutants. Even though new indirect dischargers are not subject to categorical pretreatment standards, they must comply with the General Pretreatment Regulations (40 CFR Part 403).

SECTION XIV

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

The 1977 amendments to the Clean Water Act added Section 301(b)(2)(E), establishing "best conventional pollutant control technology" (BCT) for discharge of conventional pollutants from existing industrial point sources. Section 304(a)(4) designated the following as conventional pollutants: biochemical oxygen demand (BOD_5), total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease "conventional" on July 30, 1979 (44 FR 44501).

BCT is not an additional limitation but replaces BAT for the control of conventional pollutants. In addition to other factors specified in Section 304(b)(4)(B), the Act requires that BCT effluent limitations guidelines be assessed in light of a two part "cost-reasonableness" test. *See*, *American Paper Institute v. EPA*, 660 F.2d 954 (4th Cir. 1981). The first part of the test compares the cost for private industry to reduce its conventional pollutant discharge with the cost publicly owned treatment works incur for similar levels of reduction. The second part of the test examines the cost-effectiveness of additional industrial treatment beyond BPT. EPA must find that the BCT effluent limitations guidelines are "reasonable" under both parts of the test before they are established. In no case may BCT be less stringent than BPT.

EPA published its methodology for carrying out the BCT analysis on August 29, 1979, (44 FR 50732). In the case mentioned above, the Court of Appeals ordered EPA to correct data errors underlying EPA's calculation of the first test and to apply the second cost test. (EPA had argued that a second cost test was not required.)

On October 29, 1982, the Agency proposed a revised BCT methodology (47 FR 49176). This proposed methodology was used to determine whether costs of additional controls for the conventional pollutants beyond BPT in the PM&F category are "reasonable." EPA will conduct the two-part cost test again when the final BCT methodology is promulgated. That test will also be conducted again if the BPT model treatment technology for the final PM&F regulation is different than the selected technology for the proposed regulation.

The Agency reviewed treatment technologies that could be used to remove additional conventional pollutants after BPT. The only technology considered feasible in each subcategory is flow reduction and zero discharge by contract haul of the discharge from

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the recycle unit. Thus, one BCT Option, which is the same as BPT Option 3, was considered for each subcategory.

The Agency compared the BCT Option to BPT Option 2 in both subcategories using the proposed two part cost reasonable test. Table XIV-1 presents the information required to perform the two part cost test on the proposed BCT treatment technology for the contact cooling and heating water subcategory. Table XIV-2 presents the information required to perform the cost test on the proposed BCT treatment technology for the cleaning and finishing water subcategory.

Table XIV-1

ANNUAL COSTS OF TREATMENT AND POLLUTANT MASSES AFTER TREATMENT CONTACT COOLING AND HEATING WATER SUBCATEGORY

Level of Treatment	Mass of Pollutant Discharged (BOD_5 + TSS, million lbs)	Increment	Annual Cost of Treatment ($ millions)	Increment
Existing Treatment	17.5		0	
		14.9		9.4
BPT Option 2	2.6		9.4	
		2.6		31.8
BCT Option	0		41.2	

Table XIV-2

ANNUAL COSTS OF TREATMENT AND POLLUTANT MASSES AFTER TREATMENT CLEANING AND FINISHING WATER SUBCATEGORY

Level of Treatment	Mass of Pollutant Discharged (BOD_5 + TSS, million lbs)	Increment	Annual Cost of Treatment ($ millions)	Increment
Existing Treatment	1.49		0	
		1.35		1.5
BPT Option 2	0.14		1.5	
		0.14		4.5
BCT Option	0		6.0	

Part 1 of the cost test, the POTW test, compares the cost for industry to remove a pound of conventional pollutants to the cost incurred by a POTW for removing a pound of conventional pollutants. The Agency compared the costs by first calculating the incremental annual costs incurred by industry for conventional pollutant removals beyond BPT. Annual costs include operation and maintenance expenses, interest, and depreciation. The Agency also calculated the incremental removal of conventional pollutants by determining the difference between the annual pounds of conventional pollutants removed after compliance with BPT and the pounds removed after compliance with the BCT option.

The conventional pollutants subject to this review fall into two categories: total suspended solids (TSS) and oxygen demanding substances (BOD_5 and oil and grease). To avoid "double counting" of the incremental amount of pollutants removed, pollutant removals were calculated using only one pollutant from the oxygen demanding substances group, as specified in the proposed methodology. The Agency used the incremental amount of BOD_5 removed in the BCT cost test calculation for both PM&F subcategories because while both BOD_5 and oil and grease are regulated, a greater amount of BOD_5 is removed by treatment.

The Agency calculated the ratio of incremental annual cost to incremental conventional pollutant removal for each subcategory as follows: (BCT Option annual cost minus BPT Option 2 annual costs) divided by (BCT Option pounds of conventional pollutants removed minus BPT Option 2 pounds of conventional pollutants removed). The incremental removal cost must be equal to or less than a proposed benchmark of $0.47 per pound to be considered reasonable. The incremental removal cost was $12.23 per pound (31.8/2.6) for contact cooling and heating water and $32.14 per pound (4.5/0.14) for cleaning and finishing water. All costs are calculated in 1982 dollars. These costs are considered unreasonable.

Part 2 of the cost test, the industry cost test, compares the compliance costs and the effluent reduction benefits at BPT to those for the BCT Option. This ratio is calculated as follows: (total annual cost per pound of conventional pollutant removed between BPT and BCT) divided by (the total annual costs per pound of pollutant removed between existing treatment and BPT). This increasing cost ratio should not exceed a proposed benchmark of 1.43 if the costs of the BCT Option are to be considered reasonable. The increasing cost ratio calculated for the contact cooling and heating water subcategory is 19.4 ($12.23/$0.63). The increasing cost ratio calculated for the cleaning and finishing subcategory is 28.9 ($32.14/$1.11). Thus, the costs associated with the BCT Option are also unreasonable based on results of the second part of the proposed cost test.

Based on the preliminary results of the proposed two-part BCT cost test, costs associated with the additional removal of conventional pollutants are not "reasonable." The Agency proposes, therefore, that BCT equal BPT for each subcategory and that no further controls be established for the conventional pollutants beyond BPT.

SECTION XV

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Thomas M. Lachajczyk	Senior Environmental Engineer, Envirodyne Engineers, Inc.
Daniel L. Logan	Environmental Engineer, Envirodyne Engineers, Inc.
Robert A. Bessent	Environmental Engineer, Envirodyne Engineers, Inc.
Albert P. Becker	Chemical Engineer, Envirodyne Engineers, Inc.

Cindy L. Dahl	Environmental Engineer, Envirodyne Engineers, Inc.
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Calvin L. Spencer	Project Director, Radian Corporation
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SECTION XVII

GLOSSARY

This section contains the definitions of the technical terms used in this document. Table XVII-1 lists some common plastic polymers and their uses and properties.

Acidity

The acidity of water is its quantitative capacity to react with a strong base to a designated pH. Various materials may contribute to the measured acidity depending on the method of determination. These materials include strong mineral acids, weak acids such as carbonic and acetic acids, and hydrolyzing salts such as ferrous or aluminum sulfates.

Alkalinity

Alkalinity of a water is its quantitative capacity to react with a strong acid to a designated pH. It is an indication of the concentration of any carbonate, bicarbonate and hydroxide ions present.

Analytical Quantification Limit

The minimum concentration at which a pollutant can be accurately measured. It is also known as the method detection limit.

Average Process Water Usage Flow Rate for Processes That Use Contact Cooling and Heating Water

The average process water usage flow rate of a process in gallons per minute is equal to the volume of the process water (gallons) used per year by a process divided by the total time (minutes) per year the process operates. The average process water usage flow rate for a plant with more than one plastics molding and forming process that uses contact cooling and heating water is the sum of the average process water usage flow rates for those plastics molding and forming processes.

Batch Treatment

Batch treatment is a waste treatment method where wastewater is collected over a period of time and then treated prior to discharge. Collection may be continuous even though treatment is not. Batch treatment may be used because the processes generating wastewater are operated on a batch operation mode, or the treatment system may be oversized for the amount of wastewater generated.

Biological Oxygen Demand (BOD_5)

The biological oxygen demand (BOD_5) test for wastewaters determines the oxygen required for the biochemical degradation of organic material (carbonaceous demand) and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron. The wastewater sample is incubated for a standard period of five days, hence the common name BOD_5.

Blowing Agent

A blowing agent is the material injected into a plastic material that cause the plastic material to expand with the application of heat. Blowing agents can be gases introduced into the molten plastic or a gas producing compound that is mixed with the polymer before processing.

Blow Molding

Blow molding expands a parison into a desired shape with compressed air. Hollow, thin-wall objects from thermoplastic resins are formed.

BPT Regulatory Flow

The BPT regulatory flow is the production normalized flow chosen to calculate the effluent limitations guidelines based on BPT.

Calendering Process

The calendering process squeezes pliable thermoplastic between a series of rolls to produce uniform quality polymer film and sheet, to emboss sheet and film, to perform compounding operations, and to coat textiles and papers.

Casting Process

A casting process forms products by allowing a liquid plastic to cure at atmospheric pressure in a mold or on a mold surface.

Chemical Oxygen Demand (COD)

The chemical oxygen demand (COD) is a measure of the oxygen equivalent of the organic matter content of a wastewater sample that is susceptible to oxidation by a strong chemical oxidant.

Chiller System

A chiller system is a heat exchange device that uses a refrigeration medium to lower the temperature of water. This system is used in water recycle systems in the PM&F industry.

Cleaning Process

A cleaning process is a process in which plastic parts and shaping equipment are washed to remove residual mold release agents and other matter prior to finishing or further processing. A cleaning process contains a detergent wash cycle, and a rinse cycle.

Cleaning Water

Cleaning water is process water used to clean an intermediate or final plastic product or to clean equipment used in plastic molding and forming that contacts an intermediate or final product. It includes water used in both the detergent wash and rinse cycles of a cleaning process.

Coating Process

A coating process covers objects with a polymer layer that is in the form of a melt, liquid, or finely divided powder. These objects include other plastic materials, metal, wood, paper, fabric, leather, glass, concrete, and ceramics.

Compounding

Compounding is the plastics processing step where a plastic resin is mixed with additives or fillers.

Compression Molding

Compression molding shapes a measured quantity of plastic within a mold by applying heat and pressure to form products with large surface areas and relatively simple shapes.

Contact Cooling and Heating Water

Contact cooling and heating water is process water that contacts the raw materials or plastic product for the purpose of heat transfer during plastic molding and forming.

Conventional Pollutants

Conventional pollutants are the pollutants defined in Section 304(a)(4) of the Clean Water Act. They include biological oxygen demand, oil and grease, suspended solids, fecal coliform, and pH.

Cooling Tower

A cooling tower is a hollow vertical structure with internal baffles designed to exchange the heat of water with counter or cross-current flowing air.

Cooling Trough

A cooling trough is a long open box-like container that holds water to quench a processed plastic product. It is commonly used to contact cool extruded strands before they are pelletized, and to cool extruded pipe.

Direct Discharger

A direct discharger is an industrial water user that discharges wastewater directly in a navigable stream.

Dry Process

A dry process is a process that uses no proces water or uses only noncontact water.

Effluent

Effluent is the discharge from a point source after treatment.

End-of-Pipe Treatment

End-of-pipe treatment is the treatment given wastewater before the wastewater is discharged from the treatment plant.

Extrusion Process

Extrusion is the process that forces molten polymer under pressure through a shaping die to produce products of uniform cross-sectional area such as pipe, tubing, sheet, and film.

Filler

A filler is a material that when added to a plastic may reduce the end product cost by occupying a fraction of the volume of the plastic product. It may also act as a speciality additive to improve the final product.

Finishing Process

A finishing process renders the plastic parts useful. There are three types of finishing processes: machining, decorating, and assembling.

Finishing Water

Finishing water is process water used to remove waste plastic material generated during a finishing process or to lubricate a plastic product during a finishing process. It includes water used to machine, to decorate, or to assemble intermediate or final plastic products.

Foaming Agent

A foaming agent is a gas producing compound added to a polymer that causes the polymer to foam when the gas is liberated by the addition of heat or a reduction in pressure.

Foaming Process

A foaming process injects a blowing or foaming agent into a thermoplastic or thermoset to form a sponge-like material.

Glass Transition Temperature

The temperature at which a polymer changes from a brittle glassy solid to a rubberlike substance.

Indirect Discharger

An indirect discharger is an industrial source that discharges wastewater to a publicly owned treatment works.

Influent

Influent is water used in a PM&F process. It can be the source water for a plant or the source water combined with recycled water.

Injection Molding

Injection molding forms intricate plastic parts by forcing a heated plastic with pressure into a mold cavity.

In-Process Control Technology

In-process control technology is the conservation of water throughout the production processes to reduce the amount of wastewater discharged.

Integrated Plant

An integrated plant is a plant that combines process water from all sources in the plant for treatment in a wastewater treatment process.

Laminating Process

The laminating process combines layers of polymeric materials with other materials through high pressure. These structures are formed from layers of resins and fillers bonded together as a unit with the resin used as a reinforcing agent.

Mass of Plastic Material Processed In Cleaning and Finishing Water Processes

The mass of plastic material processed (kg or lbs) when used to determine effluent limitations guidelines is the mass of plastic material that process water comes in contact with for product cleaning or finishing purposes. If the same unit mass of plastic material undergoes more than one cleaning or finishing process (for example, it is cleaned and finished), the mass of plastic material processed in each process is added to obtain the total mass of plastic material processed. For the purpose of calculating effluent limitations for water used to clean shaping equipment, such as molds and mandrels, "mass of plastic material processed" refers to the mass of plastic material that was molded or formed by the shaping equipment being cleaned.

Mass of Plastic Material Procssed In Contact Cooling and Heating Water Processes

The mass of plastic material processed (kg or lbs) when used to determine effluent limitations guidelines is the mass of plastic material that process water comes in contact with for cooling or heating purposes. If the same unit mass of plastic undergoes more than one molding and forming process (for example, it is compounded and pelletized, extruded, and blow molded), the mass of plastic material processed in each process is added to obtain the total mass of plastic material processed.

Melt Temperature

The temperature at which a polymer becomes fluid.

Monomer

A monomer is a chemical compound that during a polymerization process becomes a repeating link in the polymer chain.

New Source Performance Standards (NSPS)

NSPS for new industrial direct dischargers as defined by Section 306 of the Clean Water Act are based on the best available demonstrated technology.

Nonconventional Pollutants

Nonconventional pollutants include pollutants that are not designated as either conventional or priority toxic pollutants.

Oil and Grease

Oil and grease are materials that are soluble in trichlorotrifluoroethane. They include nonvolatilized materials usch as hydrocarbons, fatty acids, soaps, fats, waxes, and oils.

Parison

A parison is a preshaped sleeve usually made by extrusion. This sleeve is an intermediate product often used as the starting material for the blow molding process.

Pelletizing

Pelletizing is a process by which long extruded strands are cut into pellets. These pellets are an intermediate product which can be the feed material of other plastic molding and forming processes.

pH

pH is the negative logarithm of the hydronium ion concentration. Values below seven represent an acid environment; a value of seven represents a neutral environment; and values greater than seven are indicative of a basic environment.

Pigments

A pigment is a compound that when well mixed with a polymer imparts color to the polymer. To impart color, the pigment must absorb light in the visible wavelength range.

Plastic

A plastic is a polymeric material of large molecular weight that can be shaped by flow. A plastic material includes the pure polymer and any fillers, plasticizers, pigments, or stabilizers.

Plasticization - Internal

A copolymerization process by which a chain is made more flexible. The chain's rigidity is caused by steric factors.

Plasticizer - External

An external plasticizer is usually a monomeric molecule that when mixed with polar or hydrogen bonded polymer results in increasing the flexibility of the rigid polymer.

Plastics Molding and Forming (PM&F) Processes

Plastic molding and forming processes are a group of manufacturing processes in which plastic materials are blended, molded, formed, or otherwise processed into intermediate or final plastic products.

Plastisol

A plastisol is a low viscosity system of dispersed polyvinyl chloride (PVC) in a plasticizer.

PM&F Category

Throughout this document, the PM&F abbreviation stands for the Plastics Molding and Forming category.

Pollutant Concentration

A measure of the mass of pollutant per volume of wastewater. Commonly used units are milligrams per liter.

Pollutant Effluent Limitations Guidelines

The pollutant effluent limitations guidelines is the mass of pollutant allowed to be discharged per unit of plastic production. For the PM&F category typical units are milligrams of pollutant per kilogram of plastic production.

Polymer

A polymer is a macromolecule comprised of linked together repeating monomers. These macromolecules have molecular weights in the range of 10^4 to 10^7.

Polymerization

Polymerization is the chemical reaction that produces a polymer.

Priority Toxic Pollutants

Priority toxic pollutants are toxic pollutants selected for study from 65 compounds and classes of compounds Congress declared toxic under Section 307(a) of the Clean Water Act.

Process Water

Process water is any raw, service, recycled, or reused water that contacts the plastic product or contacts shaping equipment surfaces such as molds and mandrels that are, or have been, in contact with the plastic product.

Production Normalized Flow (PNF)

The PNF is the amount of wastewater discharged from a process divided by the amount of plastic material processed in that process (i.e., liters discahrged per kkg of plastic material processed).

Publicly Owned Treatment Works (POTW)

A POTW is a wastewater treatment facility owned by a state or municipality.

Reaction Injection Molding (RIM)

A RIM process simultaneously injects two or more reactive liquid streams at high pressure into a mixing chamber and then injects the plastic at a lower pressure into the mold cavity.

Recycle

Recycle is a water-saving technology that returns process water that has been used in a process to that process.

Regrind

Regrind is processed plastic that is scrapped and mixed with pure plastic and reprocessed.

Reinforcing Agent

A reinforcing agent primarily improves the strength and stiffness of the base polymer.

Resin

A resin is the homogeneous polymer that forms the basis of a plastic product. The resin does not include the fillers, plasticizers, pigments or stabilizers.

Rotational Molding

A rotational molding process rotates a polymer powder or liquid inside a large, heated mold to form hollow objects from thermoplastic materials.

Sprue

The sprue is the entrance into the mold through which the plastic flows.

Stabilizer

A stabilizer is a compound which when added to a polymer protects it from heat, light, or oxygen.

Thermoforming Process

A thermoforming process heats a thermoplastic sheet or film to a pliable state and forces it around the contours of a mold. Vacuum, air pressure, or mechanical force form the molten sheet to the mold.

Thermoplastic Polymer

A thermoplastic polymer is a linear molecule that can melt and flow with the addition of heat and pressure.

Thermoset Polymer

A thermoset polymer has crosslinks throughout the chain making it stable to heat. The polymer will not melt or flow with heat.

Total Organic Carbon (TOC)

TOC is a measure of the organic material in a wastewater and is determined by oxidizing the organic material to carbon dioxide.

Total Phenols

Phenols are hydroxy derivatives of benzene.

Total Suspended Solids (TSS)

TSS is a measure of the solids in wastewater.

Transfer Molding

Transfer molding uses a preheated plastic and moves it into the mold cavity with pressure through a sprue. It is similar to injection molding.

Treatability Limit

The treatability limit is the lowest attainable concentration achievable by a wastewater treatment process.

Volume of Process Water Used Per Year

The volume of process water used per year is the volume of process water that flows through a process and comes in contact with the plastic product over a period of one year.

Wastewater Discharged

Wastewater discharged is process water from a PM&F process that is discharged to surface water or a POTW.

Water Quench

A water quench is a contact water cooling bath used to quickly cool a material. It is often used in extrusion and injection molding to cool the products.

Water Used

Water used is water that contacts the plastic material or product. This includes any recycle and makeup water.

Wet Process

A wet process is a process in which the plastic comes into direct contact with water.

Zero Discharger

A zero discharger is any industrial water user that does not discharge wastewater.

Table XVII-1

THE GLASS TRANSISTION AND MELTING TEMPERATURES OF SOME COMMON POLYMERS, AND THEIR MAIN USES*

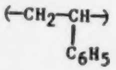
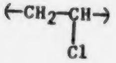
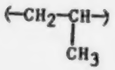
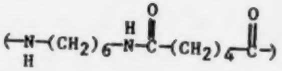
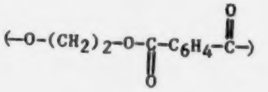
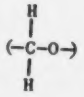
Polymer	Repeat Unit	Abbreviation	T_g (°C)	T_m (°C)	Main Uses
Linear polyethylene	$(-CH_2-CH_2-)$	HDPE	-110	134	Extruded and injection molded articles, bottles, and containers
Branched polyethylene	$(-CH_2-CH_2-)$	LDPE	-110	115	Flexible packaging film; flexible extruded and molded articles
Polystyrene	 $(-CH_2-\underset{C_6H_5}{\underset{\vert}{CH}}-)$	PS	90-100	---	Extruded and molded articles that are transparent; foamed articles
Polyvinylchoride	 $(-CH_2-\underset{Cl}{\underset{\vert}{CH}}-)$	PVC	87	---	Extruded rigid or plasticized articles, tubes, sheets, profiles
Polypropylene	 $(-CH_2-\underset{CH_3}{\underset{\vert}{CH}}-)$	PP	-10	165	Extruded and molded articles that are rigid
Nylon 6-6	 $(-\underset{H}{N}-(CH_2)_6-\overset{H}{N}-\overset{O}{\overset{\Vert}{C}}-(CH_2)_4-\overset{O}{\overset{\Vert}{C}}-)$	--	50	240	Fibers; molded and extruded rigid articles
Polyethylene terephthalate	 $(-O-(CH_2)_2-O-\underset{O}{\underset{\Vert}{C}}-C_6H_4-\overset{O}{\overset{\Vert}{C}}-)$	PET	70	260	Fibers and transparent strong films
Polyoximethylene	 $(-\overset{H}{\overset{\vert}{\underset{\underset{H}{\vert}}{C}}}-O-)$	Acetal	-50	180	Molded "engineering" structural components; tough

Table XVII-1 (Continued)

THE GLASS TRANSISTION AND MELTING TEMPERATURES OF SOME COMMON POLYMERS, AND THEIR MAIN USES*

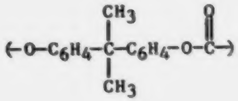
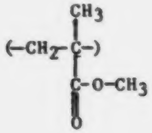
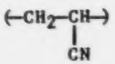
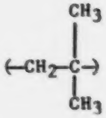
Polymer	Repeat Unit	Abbreviation	T_g (°C)	T_m (°C)	Main Uses
Polycarbonate	 $(-O-C_6H_4-\overset{CH_3}{\overset{\vert}{\underset{\underset{CH_3}{\vert}}{C}}}-C_6H_4-O-\overset{O}{\overset{\Vert}{C}}-)$	PPO	150	---	Molded tough and transparent articles; structural components
Polymethylmethacrylate	 $(-CH_2-\overset{CH_3}{\overset{\vert}{\underset{\underset{\underset{\underset{O}{\Vert}}{C-O-CH_3}}{\vert}}{C}}}-)$	PMMA	90-100	---	Cast transparent sheet; molded articles
Polytetrafluoroethylene	$(-CF_2-CF_2-)$	Teflon, PTFE	125	327	"Extruded" tubes; sintered blocks for machining; tapes; solvent resistant
Polyacrylonitrile	 $(-CH_2-\underset{\underset{CN}{\vert}}{CH}-)$	PAN	105	>250	High strength fibers
Polyisobutylene	 $(-CH_2-\overset{CH_3}{\overset{\vert}{\underset{\underset{CH_3}{\vert}}{C}}}-)$	PIB	-70	---	Adhesives, paper coatings; together with isoprene, butyl rubber
Polybutadiene	$(-CH_2-CH=CH-CH_2-)$	---	-88	---	Styrene-butadiene rubber (SBR); nitrile rubbers (with PAN); oil resistant

*Table is from Principles of Polymer Processing, Tadmor Z, Gogos C. G., John Wiley and Sons, 1979, pp. 38-39.

APPENDIX A

SAMPLING DATA

APPENDIX A

SAMPLING DATA

This appendix presents the daily raw concentration data from the 11 plants in the plastics molding and forming category sampled during this project. Table A-1 lists the data for the contact cooling and heating water subcategory and Table A-2 presents the data for the cleaning and finishing water subcategory. The concentrations for days one, two, three, and the duplicate listed in Tables A-1 and A-2 were used to develop Table VI-17.

Processes from Plant K have two source water concentrations listed. The first value listed represents the concentration of a make-up water flow and the second value represents a recirculated water flow to the process. Some pollutants for process K-4 from Plant K have two concentration values listed under each sampling day. The first concentration is from an unpreserved sample and the second listed value is from a preserved sample.

A wastewater treatment system that treats primarily PM&F wastewater was sampled at one plant (i.e., Plant I) in 1980. Tables A-3 and A-4 present influent and effluent data for two treatment systems at that plant (see Figure VI-9).

Table A-5 presents solution casting solvent recovery sampling data for Plant G. Data presented in Table A-5 may be used as a guide by the permit writer to write permits for the solvent recovery wastewater.

Table A-1

SAMPLING DATA BY POLLUTANT FOR CONTACT COOLING AND HEATING WATER SUBCATEGORY (RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Conventional Pollutants							
biological oxygen demand (BOD_5)	B-1	1	<5	<5			
	B-4	1	<5	<5			<5
	C-1	1	83.8	96.9	84.8	90.9	
	D-3	1	NA	NA			
	E-1	1	5.0	7.2	6.1	2.5	
	E-2	1	5.0	9.4	8.9	4.1	
	E-3	1	5	7.6	3.9	0.5	
	E-4	1	5.0	8.9	6.1	2.5	
	F-1	1	2	10	8	10	
	F-2	1	2	8	7	7	
	F-6	1	2		5	3	
	G-1	3	<5	††	††		
	H-1	1	<5.0	1000	630		850
	J-1	2	<5	<5			
	J-2	2	<5	56			52
	K-2	3/1	<5/<5	<5	<5	<5	
	K-3	3/1	<5/<5	<5	<5	<5	<5
	K-4	3/1	<5/<5	<5	<5	<5	
oil and grease	B-1	2	<4	<4			
	B-4	2	<4	4			10
	C-1	1	17.0	75.0	24.5	41.0	
	D-3	2	<4	<4			<4
	E-1	1	19.6	20.8	13.6	23.0	
	E-2	1	19.6	16.8	23.8	11.8	
	E-3	1	19.6	20.0	27.8	19.4	
	E-4	1	19.6	21.0	13.6	23.0	
	F-1	1	3	1	0	4	
	F-2	1	3	3	0	5	
	F-6	1	3		5	4	
	G-1	2	6	<4	4		
	H-1	2	<4.0	<4.0	<4.0	<4.0	
	J-1	2	<4	11			
	J-2	2	<4	73			49
	K-2	2	<4/<4	<4	<4	<4	
	K-3	2	<4/<4	<4	<4	<4	<4
	K-4	2	<4/<4	<4	<4	<4	

§See Figures VI-1 through VI-11.

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Source	Concentrations (mg/l) Day 1	Day 2	Day 3	Duplicate
Conventional Pollutants (Continued)							
pH	B-1	1	5.6	5.7			
	B-4	1	5.6	5.8			5.8
	C-1	3	5.8	5.4	6.65	6.0	
	D-3	1					
	E-1	3	6.55	6.90	6.82	6.09	
	E-2	3	6.55	6.5	6.6	6.5	
	E-3	3	6.55	6.35	6.51	6.41	
	E-4	3	6.55	6.5	6.82	6.09	
	F-1	3	7.6	7.65	7.7	7.65	
	F-2	3	7.6	8.0	7.6	7.55	
	F-6	3	7.6		7.6	7.55	
	G-1	3	7.4	7.7	7.6		
	H-1	1	5.7	4.8	5.7		4.8
	J-1	2	8.55	8.3			
	J-2	2	8.55	8.2			8.2
	K-2	3	8.0/8.0	8.2	8.3	7.9	
	K-3	3	8.0/8.0	8.0	7.9	8.0	7.9
	K-4	3	8.0/8.0	8.0	7.9	8.0	
total suspended solids (TSS)	B-1	1	<4	<4			
	B-4	1	<4	4			<4
	C-1	3	0	104	77.0	18.0	
	D-3	1	<4	<4			<4
	E-1	3	1	2	4	2	
	E-2	3	1	3	4	2	
	E-3	3	1	4	2	3	
	E-4	3	1	4	4	2	
	F-1	3	2	6	3	5	
	F-2	3	2	<1	2	1	
	F-6	3	2		1	<1	
	G-1	3	16	22	4		
	H-1	1	5.0	11.0	<4.0		10.0
	J-1	2	<4	4			
	J-2	2	<4	36			38
	K-2	3	<4/6	6	4	<4	
	K-3	3	<4/<4	<4	<4	<4	<4
	K-4	3	<4/4	4	<4	4	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants							
aluminum	B-1	1	0.100	0.800			
	B-4	1	0.100	0.500			
	C-1	3	ND	0.310	0.200	0.041	
	D-3	1	0.11	0.073			
	E-1	3	0.155	0.046	0.045	0.020	
	E-2	3	0.155	0.047	0.126	0.036	
	E-3	3	0.155	0.040	0.022	ND	
	E-4	3	0.155	0.030	0.276	0.018	
	F-1	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.662	0.513		
	H-1	1	ND	ND	ND		
	J-1	2	ND	0.163			
	J-2	2	ND	0.235			
	K-2	3/1	ND/0.200	0.100	0.100	0.100	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/0.1	ND	ND	0.1	
ammonia nitrogen	B-1	1	0.06	0.06			
	B-4	1	0.06	<0.05			<0.05
	C-1	3	0	0	8.4	1.68	
	D-3	1	<0.05	<0.05			<0.05
	E-1	3	<0.05	0.18	<0.05	0.13	
	E-2	3	<0.05	<0.05	<0.05	0.09	
	E-3	3	<0.05	0.39	<0.05	<0.05	
	E-4	3	<0.05	<0.05	<0.05	0.13	
	F-1	3	3.3	0.61	3.1	1.1	
	F-2	3	3.3	1.1	2.4	0.7	
	F-6	3	3.3		6.4	1.8	
	G-1	3	<0.05	<0.05	<0.05		
	H-1	1	0.09	<0.05	0.05		0.07
	J-1	2	<0.05	0.05			
	J-2	2	<0.05	0.05			0.05
	K-2	3	<0.05/0.24	0.10	0.12	0.14	
	K-3	3	<0.05/<0.05	<0.05	<0.05	<0.05	<0.05
	K-4	3	<0.05/<0.05	<0.05	<0.05	<0.05	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
barium	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	0.190	0.180	0.180	
	D-3	1	0.034	0.035			
	E-1	3	0.014	0.013	0.013	0.012	
	E-2	3	0.014	0.020	0.035	0.016	
	E-3	3	0.014	0.014	0.014	0.015	
	E-4	3	0.014	0.012	0.013	0.012	
	F-1	3	0.043	0.063	0.085	0.100	
	F-2	3	0.043	0.052	0.088	0.110	
	F-6	3	0.043		0.14	0.17	
	G-1	3	ND	0.040	0.018		
	H-1	1	ND	ND	ND		
	J-1	2	0.030	0.012			
	J-2	2	0.030	0.016			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	
boron	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	ND	ND	0.030	
	D-3	1	0.050	0.038			
	E-1	3	0.207	ND	0.007	ND	
	E-2	3	0.207	0.016	0.007	ND	
	E-3	3	0.207	ND	0.013	0.029	
	E-4	3	0.207	0.026	ND	ND	
	F-1	3	0.051	0.17	0.13	0.12	
	F-2	3	0.051	0.060	0.110	0.065	
	F-6	3	0.051		0.065	0.047	
	G-1	3	ND	0.103	0.01		
	H-1	1	ND	ND	ND		
	J-1	2	0.174	0.169			
	J-2	2	0.174	0.150			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
bromide	B-1	1	<0.4	<0.4			
	B-4	1	<0.4	<0.4			<0.4
	C-1		NA	NA	NA	NA	
	D-3	1	<0.4	<0.4			<0.4
	E-1		NA	NA	NA	NA	
	E-2		NA	NA	NA	NA	
	E-3		NA	NA	NA	NA	
	E-4		NA	NA	NA	NA	
	F-1		NA	NA	NA	NA	
	F-2		NA	NA	NA	NA	
	F-6		NA		NA	NA	
	G-1	3	0.56	0.55	0.8		
	H-1	1	<0.4	<0.4	<0.4		<0.4
	J-1	2	<0.4	<0.4			
	J-2	2	<0.4	<0.4			<0.4
	K-2	3/1	<0.4/<0.4	<0.4	<0.4	<0.4	
	K-3	3/1	<0.4/<0.4	<0.4	<0.4	<0.4	<0.4
	K-4	3/1	<0.4/<0.4	<0.4	<0.4	<0.4	
calcium	B-1	1	2.100	2.900			
	B-4	1	2.100	2.000			
	C-1	3	6.840	11.500	11.100	10.400	
	D-3	1	21.4	16.1			
	E-1	3	9.520	9.640	9.710	9.010	
	E-2	3	9.52	9.39	9.32	8.9	
	E-3	3	9.52	9.33	9.32	9.09	
	E-4	3	9.52	9.16	8.94	9.01	
	F-1	3	33.2	48.8	73.8	90.7	
	F-2	3	33.2	38.1	75.6	93.6	
	F-6	3	33.2		87.8	90.8	
	G-1	3	0.062	394	406		
	H-1	1	0.194	0.098	ND		
	J-1	2	25.850	16.400			
	J-2	2	25.850	17.900			
	K-2	3/1	20.4/23.8	22.2	22.9	25.6	
	K-3	3/1	20.4/20.7	20.4	20.9	20.3	
	K-4	3/1	20.4/23	19.9	20.8	21.7	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
chemical oxygen demand (COD)	B-1	1	<5	<5			
	B-4	1	<5	<5			<5
	C-1	3	0	377.2	322.4	352.8	
	D-3	1	<5	10			14
	E-1	3	30	46.6	38.2	11.9	
	E-2	3	30	72.1	29.7	25.4	
	E-3	3	30	55.1	25.4	4.2	
	E-4	3	30	55	38.2	11.9	
	F-1	3	8294	645	35	81	
	F-2	3	8294	588	31	111	
	F-6	3	8294		53	461	
	G-1	3	<5	415	280		
	H-1	1	<5.0	2280	1150		2220
	J-1	2	15.5	60			
	J-2	2	15.5	122			125
	K-2	3/1	<5/<5	51	12	36	
	K-3	3/1	<5/<5	192	<5	5	<5
	K-4	3/1	<5/<5	40	<5	7	
cobolt	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	0.043	0.032	0.028	
	D-3	1	ND	ND			
	E-1	3	ND	0.127	0.105	0.081	
	E-2	3	ND	0.136	0.142	0.084	
	E-3	3	ND	0.136	0.115	0.060	
	E-4	3	ND	0.082	0.056	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	1	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.051	0.058		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
cyanide (amenable)	B-1		NA	NA			
	B-4		NA	NA			NA
	C-1	1	0	0	0	0	
	D-3		NA	NA			
	E-1	1	<0.005	<0.005	<0.005	<0.005	
	E-2	1	<0.005	<0.005	<0.005	<0.005	
	E-3	1	<0.005	<0.005	<0.005	<0.005	
	E-4	1	<0.005	<0.005	<0.005	<0.005	
	F-1	1	0	0	0	0	
	F-2	1	0	0	0	0	
	F-6	1	0		0	0	
	G-1		NA/NA	NA	NA	NA	
	H-1		NA	NA	NA		
	J-1		NA	NA			
	J-2	2	ND	<0.010			<0.010
	K-2		NA/NA	NA	NA	NA	
	K-3		NA/NA	NA	NA	NA	NA
	K-4		NA/NA	NA	NA	NA	
fluoride	B-1	1	1.2	0.85			
	B-4	1	1.2	0.91			0.95
	C-1		NA	NA	NA	NA	
	D-3	1	0.95	0.95			1.25
	E-1		NA	NA	NA	NA	
	E-2		NA	NA	NA	NA	
	E-3		NA	NA	NA	NA	
	E-4		NA	NA	NA	NA	
	F-1		NA	NA	NA	NA	
	F-2		NA	NA	NA	NA	
	F-6		NA		NA	NA	
	G-1	3	0.46	0.08	0.18		
	H-1	1	0.14	<0.1	0.4		<0.1
	J-1	2	0.595	0.54			
	J-2	2	0.595	0.36			0.48
	K-2	3	0.81/1.18	1.02	1.04	1.04	
	K-3	3	0.81/0.73	0.78	0.73	0.80	0.73
	K-4	3	0.81/1.12	1.05	0.95	1.2	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
iron	B-1	1	0.300	0.400			
	B-4	1	0.300	0.500			
	C-1	3	0.140	9.850	9.450	1.640	
	D-3	1	ND	0.066			
	E-1	3	0.094	0.559	0.676	0.343	
	E-2	3	0.094	0.112	0.172	0.110	
	E-3	3	0.094	0.132	0.126	0.094	
	E-4	3	0.094	0.228	0.426	0.213	
	F-1	3	0.036	0.47	0.37	0.074	
	F-2	3	0.036	0.064	0.19	0.30	
	F-6	3	0.036		0.038	ND	
	G-1	3	ND	0.090	0.052		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	0.054			
	K-2	3/1	ND/1.05	0.85	0.80	0.75	
	K-3	3/1	ND/0.4	0.25	0.35	0.35	
	K-4	3/1	ND/0.2	0.3	0.1	0.15	
Kjeldahl nitrogen	B-1	1	<1	<1			
	B-4	1	<1	<1			<1
	C-1	3	0	0	0	0	
	D-3	1	<1	<1			<1
	E-1	3	<0.1	0.38	<0.1	0.44	
	E-2	3	<0.1	<0.1	0.1	0.22	
	E-3	3	<0.1	0.63	<0.1	<0.1	
	E-4	3	<0.1	0.1	<0.1	0.44	
	F-1	3	<0.02	<0.02	0.45	<0.02	
	F-2	3	<0.02	1.15	<0.02	<0.02	
	F-6	3	<0.02		0.35	0.45	
	G-1	3	<1	<1	<1		
	H-1	1	<1.0	<1.0	<1.0		<1.0
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	<1/<1	<1	<1	<1	
	K-3	3	<1/<1	<1	<1	<1	<1
	K-4	3	<1/<1	<1	<1	<1	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
magnesium	B-1	1	0.700	0.900			
	B-4	1	0.700	0.700			
	C-1	3	1.240	2.120	2.060	1.870	
	D-3	1	5.66	4.83			
	E-1	3	2.360	2.600	2.740	2.450	
	E-2	3	2.36	2.46	2.58	2.42	
	E-3	3	2.36	2.54	2.55	2.6	
	E-4	3	2.36	2.79	2.77	2.77	
	F-1	3	13.3	19.8	23.4	28.6	
	F-2	3	13.3	17.2	24.8	29.8	
	F-6	3	13.3		28.5	29.4	
	G-1	3	0.181	24.3	25.5		
	H-1	1	0.179	0.176	0.167		
	J-1	2	3.215	2.290			
	J-2	2	3.215	2.500			
	K-2	3/1	5.8/6.4	5.9	6.1	6.8	
	K-3	3/1	5.8/5.6	5.5	5.7	5.5	
	K-4	3/1	5.8/6.1	5.6	5.9	5.9	
manganese	B-1	1	ND	0.050			
	B-4	1	ND	0.050			
	C-1	3	0.072	0.210	0.210	0.160	
	D-3	1	0.008	0.006			
	E-1	3	0.011	0.050	0.061	0.037	
	E-2	3	0.011	0.035	0.039	0.040	
	E-3	3	0.011	0.032	0.044	0.032	
	E-4	3	0.011	0.033	0.040	0.038	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.029	0.032		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR CONTACT COOLING AND HEATING WATER SUBCATEGORY (RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
molybdenum	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	ND	0.021	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	0.045	ND	
	E-2	3	ND	ND	0.045	ND	
	E-3	3	ND	0.044	ND	ND	
	E-4	3	ND	ND	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/0.150	ND	0.15	0.15	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	
nitrate	B-1	1	<0.1	<0.1			
	B-4	1	<0.1	<0.1			<0.1
	C-1		NA	NA	NA	NA	
	D-3	1	2.0	2.1			2.1
	E-1		NA	NA	NA	NA	
	E-2		NA	NA	NA	NA	
	E-3		NA	NA	NA	NA	
	E-4		NA	NA	NA	NA	
	F-1		NA	NA	NA	NA	
	F-2		NA	NA	NA	NA	
	F-6		NA		NA	NA	
	G-1	3	5.8	6.6	6.0		
	H-1	1	<0.1	0.2	<0.1		<0.1
	J-1	2	1.05	0.35			
	J-2	2	1.05	0.40			0.40
	K-2	3	1.05/1.4	0.75	1.35	1.35	
	K-3	3	1.05/0.70	0.75	0.75	0.70	0.70
	K-4	3	1.05/1.2	1.1	1.1	1.15	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR CONTACT COOLING AND HEATING WATER SUBCATEGORY (RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
sodium	B-1	1	1.800	2.100			
	B-4	1	1.800	1.800			
	C-1	3	11.400	18.600	18.900	17.400	
	D-3	1	26.2	22.3			
	E-1	3	10.800	10.200	9.980	11.700	
	E-2	3	10.8	10.8	8.71	10.7	
	E-3	3	10.8	10.7	8.82	11.2	
	E-4	3	10.8	8.72	10.3	9.09	
	F-1	3	17.7	169.0	119.0	91.4	
	F-2	3	17.7	170	117	88.9	
	F-6	3	177.0		97.2	86.5	
	G-1	3	ND	18.8	207		
	H-1	1	ND	5.75	ND		
	J-1	2	70.400	58.000			
	J-2	2	70.400	53.900			
	K-2	3/1	8.1/10.2	8.6	9.2	10.5	
	K-3	3/1	8.1/7.5	7.3	7.6	7.4	
	K-4	3/1	8.1/9.3	8.1	8.7	8.8	
sulfate	B-1	1	9	5			
	B-4	1	9	<5			<5
	C-1		NA	NA	NA	NA	
	D-3	1	33	33			30
	E-1		NA	NA	NA	NA	
	E-2		NA	NA	NA	NA	
	E-3		NA	NA	NA	NA	
	E-4		NA	NA	NA	NA	
	F-1		NA	NA	NA	NA	
	F-2		NA	NA	NA	NA	
	F-6		NA		NA	NA	
	G-1	3	1040	<5	890		
	H-1	1	<5.0	<5.0	<5.0		<5.0
	J-1	2	33	25			
	J-2	2	33	25			25
	K-2	2	10/15	11	15	15	
	K-3	2	10/11	10	11	10	11
	K-4	2	10/12	10	<5	11	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
sulfide	B-1	1	<1	<1			
	B-4	1	<1	<1			
	C-1		NA	NA	NA	NA	<1
	D-3	1	NA	NA			
	E-1		NA	NA	NA	NA	
	E-2		NA	NA	NA		
	E-3		NA	NA	NA		
	E-4		NA	NA	NA		
	F-1		NA	NA	NA	NA	
	F-2		NA	NA	NA	NA	
	F-6		NA		NA	NA	
	G-1	1	<1	<1	<1		
	H-1	1	<1.0	<1.0	<1.0		
	J-1	2	<1	<1			<1.0
	J-2	2	<1	<1			
	K-2	1	<1/<1	<1	<1	<1	<1
	K-3	1	<1/<1	<1	<1	<1	
	K-4	1	<1/<1	<1	<1	<1	<1
surfactants	B-1	1	<0.01	<0.01			
	B-4	1	<0.01	<0.01			
	C-1	3	0.08	28.86	25.7	16.09	<0.01
	D-3		NA	NA			
	E-1	3	0.12	0	0.11	0.14	
	E-2	3	0.12	0	0.10	0	
	E-3	3	0.12	0	0	0.11	
	E-4	3	0.12	0.09	0.11	0.14	
	F-1	3	<0.02	6	3.3	8	
	F-2	3	<0.02	0.02	0.05	0.07	
	F-6	3	<0.02		0.02	<0.02	
	G-1	3	<0.01	<0.01	0.10		
	H-1	1	<0.01	<0.01	<0.01		
	J-1	2	<0.015	0.045			<0.01
	J-2	2	<0.015	0.032			
	K-2	3	<0.01/ 0.01	<0.01	0.02	<0.01	0.057
	K-3	3	<0.01/ 0.01	<0.01	<0.01	<0.01	
	K-4	3	<0.01/ 0.01	<0.01	0.03	<0.01	<0.01

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR CONTACT COOLING AND HEATING WATER SUBCATEGORY (RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
tin	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	0.012	ND	ND	
	D-3	1	ND	ND			
	E-1	3	0.051	0.046	0.051	0.052	
	E-2	3	0.051	0.043	0.058	0.052	
	E-3	3	0.051	0.032	0.042	0.042	
	E-4	3	0.051	0.032	0.035	0.041	
	F-1	3	ND	0.12	0.080	0.050	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	
titanium	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	0.087	0.290	0.290	0.100	
	D-3	1	0.013	0.017			
	E-1	3	ND	0.004	0.005	ND	
	E-2	3	ND	0.006	0.009	ND	
	E-3	3	ND	ND	0.005	ND	
	E-4	3	ND	ND	0.006	ND	
	F-1	3	0.130	0.12	0.085	0.039	
	F-2	3	0.13	0.096	0.094	0.053	
	F-6	3	0.13		0.097	0.063	
	G-1	3	0.010	0.023	0.036		
	H-1	1	ND	0.01	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
total dissolved solids (TDS)	B-1		NA	NA			
	B-4		NA	NA			NA
	C-1	3	0	150.0	140.0	110	
	D-3		NA	NA			
	E-1	3	7	79	71	80	
	E-2	3	7	103	89	68	
	E-3	3	7	98	73	66	
	E-4	3	7	60	71	80	
	F-1	3	800	700	700	500	
	F-2	3	800	800	700	400	
	F-6	3	800		700	400	
	G-1		NA	NA	NA		
	H-1		NA	NA	NA		
	J-1		NA	NA			
	J-2		NA	NA			NA
	K-2		NA/NA	NA	NA	NA	
	K-3		NA/NA	NA	NA	NA	NA
	K-4		NA/NA	NA	NA	NA	
total organic carbon (TOC)	B-1	1	6	7			
	B-4	1	6	6			6
	C-1	1	3.0	48.0	40.5	29.5	
	D-3	1	2	6			4
	E-1	1	8.9	12.3	11.9	5.5	
	E-2	1	8.9	16	10.0	6.4	
	E-3	1	8.9	16.4	8.1	1.0	
	E-4	1	8.9	16.0	11.9	5.5	
	F-1	1	37	27	66	65	
	F-2	1	37	64	63	64	
	F-6	1	37		61	59	
	G-1	3	<1	144	88		
	H-1	1	2.0	800	600		792
	J-1	2	6.5	21			
	J-2	2	6.5	46			46
	K-2	3	3.0/4	30	8	14	
	K-3	3	3/0/1	72	3	4	2
	K-4	3	3.0/2	26	5	4	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
total phenols	B-1	1	<0.020	<0.020			
	B-4	1	<0.020	<0.020			<0.020
	C-1	1	1.42	1.08	16.42	20.86	
	D-3	1	<0.001	<0.001			<0.001
	E-1	1	<0.001	<0.001	<0.001	<0.001	
	E-2	1	<0.001	<0.001	<0.001	<0.001	
	E-3	1	<0.001	<0.001	<0.001	<0.001	
	E-4	1	<0.001	<0.001	<0.001	<0.001	
	F-1	1	10	36	81	238	
	F-2	1	10	<5	13	15	
	F-6	1	10		1670	108	
	G-1	2	0.023	0.100	0.220		
	H-1	1	<0.02	<0.02	<0.02		<0.02
	J-1	2	<0.020	<0.020			
	J-2	2	<0.020	<0.020			<0.020
	K-2	2	<0.001/0.01	<0.001	0.008	0.023	
	K-3	2	<0.001/<0.001	<0.001	0.026	<0.001	<0.001
	K-4	2	<0.001/0.026	<0.008	<0.001	<0.001	
total phosphorus	B-1	1	0.210	0.287			
	B-4	1	0.210	0.221			0.173
	C-1	3	1.20	<0.005	<0.005	<0.003	
	D-3	1	0.10	<0.02			0.04
	E-1	3	0.24	0.20	0.76	0.20	
	E-2	3	0.24	0.24	0.16	0.20	
	E-3	3	0.24	1.04	0.16	0.24	
	E-4	3	0.24	0.24	0.76	0.20	
	F-1	3	<0.02	3.25	3.25	2.05	
	F-2	3	<0.02	0.55	1.3	<0.02	
	F-6	3	<0.02		0.85	<0.02	
	G-1	3	0.04	0.04	0.21		
	H-1	1	<0.02	<0.02	0.04		0.05
	J-1	2	0.0435	0.53			
	J-2	2	0.0435	0.78			0.52
	K-2	3/1	0.04/0.51	0.39	0.63	0.51	
	K-3	3/1	0.04/0.08	<0.02	0.03	0.04	0.03
	K-4	3/1	0.04/0.35	0.31	0.17	0.42	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
vanadium	B-1	1	ND	ND			ND
	B-4	1	ND	ND			
	C-1	3	ND	ND	ND	ND	
	D-3	1	0.038	ND			
	E-1	3	ND	0.005	0.005	ND	
	E-2	3	ND	0.005	0.005	ND	
	E-3	3	ND	0.005	0.003	ND	
	E-4	3	ND	0.002	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.053	0.056		
	H-1	1	0.077	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	
yttrium	B-1	1	ND	ND			ND
	B-4	1	ND	ND			
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	0.006			
	E-1	3	ND	ND	ND	ND	
	E-2	3	ND	ND	ND	ND	
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.007	0.019		
	H-1	1	ND	0.005	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants							
1. acenaphthene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND		
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND		ND	
	F-1	3	ND	*	*	ND	
	F-2	3	ND	*	ND	*	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND	ND	ND	ND	
	K-3	3	ND	ND	ND	ND	ND
	K-4	3	ND	ND	ND	ND	
4. benzene	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	*	0.001	*	*	
	D-3	2	ND	ND			
	E-1	2	ND	ND	ND		
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	ND	ND		
	F-1	2	*	*	ND	*	
	F-2	2	*	*	*	*	
	F-6	2	*		*	*	
	G-1	2	ND	ND	0.019		
	H-1	2	ND	ND	ND	ND	
	J-1	2	0.003	0.004			
	J-2	2	0.003	ND			ND
	K-2	2	ND/0.008	ND	0.008	0.009	
	K-3	2	ND/0.008	ND	0.009	0.009	0.009
	K-4	2	ND/0.009	0.045/ND	0.034/ 0.008	0.005/ 0.008	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
5. benzidine	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND		
	E-4	3	ND	ND	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		*	*	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
6. carbon tetrachloride	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	ND	ND	ND	ND	
	D-3	2	ND	ND			
	E-1	2	ND	0.076	0.026		
	E-2	2	ND	ND	ND	0.008	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	2.2	2.4		
	F-1	2	ND	ND	ND	ND	
	F-2	2	ND	ND	ND	ND	
	F-6	2	ND		ND	ND	
	G-1	2	0.001	*	*		
	H-1	2	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	2	0.004/0.0055	ND	0.007	0.004	
	K-3	2	0.004/0.005	0.001	0.005	ND	0.006
	K-4	2	0.004/0.0075	ND/ND	ND/0.008	ND/ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
7. chlorobenzene	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	ND	ND	ND	ND	
	D-3	2	ND	ND			
	E-1	2	ND	ND		ND	
	E-2	2	ND	0.0032	ND	ND	0.0003
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	ND		ND	
	F-1	2	ND	ND	ND	ND	
	F-2	2	ND	*	*	*	
	F-6	2	ND		*	ND	
	G-1	2	ND	ND	ND		
	K-2	2	ND/ND	ND	ND	ND	
	K-3	2	ND/ND	ND	ND	ND	ND
	K-4	2	ND/ND	ND/ND	ND/ND	ND/ND	
10. 1,2-dichloroethane	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	ND	ND	*	ND	
	D-3	2	ND	ND			
	E-1	2	ND	ND		ND	
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	ND
	E-4	2	ND	ND		ND	
	F-1	2	ND	ND	ND	ND	
	F-2	2	ND	ND	ND	ND	
	F-6	2	ND		ND	ND	
	G-1	2	ND	ND	ND		
	H-1	2	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	2	ND	ND	ND	ND	
	K-3	2	ND	ND	ND	ND	ND
	K-4	2	ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
11. 1,1,1-trichloroethane	B-1	2	*	0.001			
	B-4	2	*	0.001			0.001
	C-1	2	ND	ND	*	ND	
	D-3	2	0.004	0.001			
	E-1	2	ND	ND	ND		
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	ND	ND		
	F-1	2	*	ND	ND	ND	
	F-2	2	*	ND	ND	ND	
	F-6	2	*		ND	ND	
	G-1	2	0.004	0.003	0.006		
	H-1	2	*	0.001	0.002		0.001
	J-1	2	0.004	0.004			
	J-2	2	0.004	*			0.001
	K-2	2	0.003/0.0115	0.001	0.036	0.007	
	K-3	2	0.003/0.001	0.001	0.001	0.004	0.002
	K-4	2	0.003/0.0275	0.011/ 0.037	0.037/ 0.093	0.015/ 0.031	
12. hexachloroethane	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	0.018	0.021		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
22. p-chloro-m-cresol	B-1	1	0.008	0.008			
	B-4	1	0.008	0.008			0.008
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	0.008	0.042	0.040		0.042
	J-1	2	0.008	0.008			
	J-2	2	0.008	0.008			0.008
	K-2	3	ND/0.043	0.042	0.042	0.043	
	K-3	3	ND/0.043	0.042	0.040	0.043	0.042
	K-4	3	ND/ND	0.042	0.042	ND	
23. chloroform	B-1	2	0.014	0.026			
	B-4	2	0.014	0.020			0.070
	C-1	2	ND	ND	ND	ND	
	D-3	2	0.019	0.010			
	E-1	2	0.068	0.042	0.068		
	E-2	2	0.068	0.048	0.058	0.070	0.115
	E-3	2	0.068	0.042	0.090	0.066	
	E-4	2	0.068	0.310	0.220		
	F-1	2	*	*	*	*	
	F-2	2	*	*	*	ND	
	F-6	2	*		*	*	
	G-1	2	0.006	0.005	0.008		
	H-1	2	ND	ND	ND		ND
	J-1	2	0.0035	ND			
	J-2	2	0.0035	ND			ND
	K-2	2	0.1015/0.001	*	ND	ND	
	K-3	2	0.1015/0.003	0.001	0.002	0.002	0.003
	K-4	2	0.1015/0.062	0.003/ 0.015	0.003/ 0.012	0.029/ 0.024	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
25. 1,2-dichlorobenzene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	*	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND		ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND	ND	ND	ND	
	K-3	3	ND	ND	ND	ND	ND
	K-4	3	ND	ND	ND	ND	
27. 1,4-dichlorobenzene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	*	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND		ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND	ND	ND	ND	
	K-3	3	ND	ND	ND	ND	ND
	K-4	3	ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
30. 1,2-trans-dichloroethylene	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	0.008	*	ND	ND	
	D-3	2	ND	ND			
	E-1	2	ND	ND		ND	
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	ND	ND		
	F-1	2	ND	ND	ND	ND	
	F-2	2	ND	ND	ND	ND	
	F-6	2	ND		ND	ND	
	G-1	2	ND	0.015	0.017		
	H-1	2	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	2	ND/ND	ND	ND	ND	
	K-3	2	ND/ND	ND	ND	ND	ND
	K-4	2	ND/ND	ND/ND	ND/ND	ND/ND	
38. ethylbenzene	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	ND	*	*	ND	
	D-3	2	ND	ND			
	E-1	2	ND	ND	ND		
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	ND	ND		
	F-1	2	ND	ND	ND	*	
	F-2	2	ND	*	*	*	
	F-6	2	ND		ND	*	
	G-1	2	ND	ND	ND		
	H-1	2	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	2	ND/ND	ND	ND	ND	
	K-3	2	ND/ND	ND	ND	ND	ND
	K-4	2	ND/ND	ND/ND	ND/ND	ND/ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
39. fluoranthene	B-1	1	ND	*			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	
	K-4	3	ND/ND	ND	ND	ND	
41. 4-bromophenylphenylether	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	0.00042	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
44. methylene chloride	B-1	2	0.001	ND			
	B-4	2	0.001	††			0.183
	C-1	2	*	0.009	0.038	0.011	
	D-3	2	0.017	0.008			
	E-1	2	0.00007	0.0016	0.0001		
	E-2	2	0.00007	0.007	0.00006	0.0001	0.0029
	E-3	2	0.00007	0.00008	0.00005	0.00008	
	E-4	2	0.00007	0.0022	0.0003		
	F-1	2	*	0.001	*	*	
	F-2	2	*	0.002	*	*	
	F-6	2	*		*	*	
	G-1	2	ND	0.33	0.024		
	H-1	2	0.003	0.003	0.043		0.008
	J-1	2	0.005	ND			
	J-2	2	0.005	0.096			0.066
	K-2	2	0.015/0.0305	ND	0.156	0.028	
	K-3	2	0.015/0.028	0.026	0.023	0.031	0.037
	K-4	2	0.015/0.0335	0.017/ND	0.041/ 0.157	0.010/ 0.030	
47. bromoform	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	ND	ND	ND	ND	
	D-3	2	ND	ND			
	E-1	2	ND	ND	ND		
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	ND	ND		
	F-1	2	0.086	0.015	0.015	0.024	
	F-2	2	0.086	0.005	0.020	0.009	
	F-6	2	0.086		0.011	0.017	
	G-1	2	ND	ND	ND		
	H-1	2	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	2	ND/ND	ND	ND	ND	
	K-3	2	ND/ND	*	ND	ND	ND
	K-4	2	ND/ND	*/ND	ND/ND	ND/ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
48. dichlorobromomethane	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	ND	ND	ND	ND	
	D-3	2	0.004	0.003			
	E-1	2	0.004	ND	ND		
	E-2	2	0.004	ND	ND	0.006	ND
	E-3	2	0.004	ND	ND	ND	
	E-4	2	0.004	0.0048	ND		
	F-1	2	*	ND	ND	*	
	F-2	2	*	ND	ND	ND	
	F-6	2	*		*	*	
	G-1	2	ND	ND	ND		
	H-1	2	ND	ND	ND		ND
	J-1	2	0.001	ND			
	J-2	2	0.001	0.002			0.002
	K-2	2	0.018/ND	0.007	0.006	0.005	
	K-3	2	0.018/ND	0.001	0.005	0.003	ND
	K-4	2	0.018/ND	0.001/ND	ND/0.007	0.005/ 0.006	
49. trichlorofluoromethane	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	ND	0.003	0.004	*	
	D-3	2	ND	ND			
	E-1	2	ND	ND	ND		
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	ND	ND		
	F-1	2	ND	ND	ND	*	
	F-2	2	ND	*	*	*	
	F-6	2	ND		*	*	
	G-1	2	ND	ND	ND		
	H-1	2	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	0.001	0.002			0.002
	K-2	2	ND/ND	ND	ND	ND	
	K-3	2	ND/ND	ND	ND	ND	ND
	K-4	2	ND/ND	ND/ND	ND/ND	ND/ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
51. chlorodibromomethane	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	ND	ND	ND	ND	
	D-3	2	ND	ND			
	E-1	2	ND	ND	ND		
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	ND	ND		
	F-1	2	0.002	*	*	0.001	
	F-2	2	0.002	*	*	*	
	F-6	2	0.002		*	*	
	G-1	2	ND	ND	ND		
	H-1	2	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	2	ND/ND	ND	ND	ND	
	K-3	2	ND/ND	ND	ND	ND	ND
	K-4	2	ND/ND	0.001/ND	ND/ND	ND/ND	
54. isophorone	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	0.00096	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Codes§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
55. naphthalene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND		
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND		ND	
	F-1	3	ND	0.018	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND	ND	ND	ND	ND
	K-3	3	ND	ND	ND	ND	ND
	K-4	3	ND	ND	ND	ND	
56. nitrobenzene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	*	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
57. 2-nitrophenol	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	0.001	0.003	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	*	0.001	0.001	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
58. 4-nitrophenol	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	0.007/*	*	ND	*	
	K-3	3	0.007/ND	ND	ND	ND	ND
	K-4	3	0.007/ND	ND	ND	0.004	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
61. N-nitrosodimethylamine	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	ND	ND	ND	ND
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	
	E-3	3	ND	ND	ND	ND	ND
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND	ND	
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3	ND/ND	ND	ND	ND	ND
	K-3	3	ND/ND	ND	ND	ND	
	K-4	3	ND/ND	ND	ND	*	ND
62. N-nitrosodiphenylamine	B-1	1	ND	*			
	B-4	1	ND	ND			
	C-1	3	ND	ND	ND	ND	ND
	D-3	1	ND	0.006			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	
	E-3	3	ND	ND	ND	ND	ND
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	*	*		
	J-1	2	ND	ND			*
	J-2	2	ND	ND			
	K-2	3	*/0.001	ND	ND	ND	ND
	K-3	3	*/*	ND	ND	ND	
	K-4	3	*/*	ND	ND	ND	ND

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
63. N-nitrosodi-n-propylamine	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	0.015	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
64. pentachlorophenol	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND		ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	4.880†††			
	J-2	2	ND	6.000†††			5.730†††
	K-2	3	ND	ND	ND	ND	
	K-3	3	ND	ND	ND	ND	ND
	K-4	3	ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
65. phenol	B-1	1	0.010	0.028			
	B-4	1	0.010	0.318			0.334
	C-1	3	*	0.780	0.810	0.91	
	D-3	1	*	ND			
	E-1	3	ND	ND	ND		
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	*	*	0.005	0.017	
	F-2	3	*	*	*	*	
	F-6	3	*		*	0.36	
	G-1	3	ND	0.179		0.434	
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	0.012	
	K-3	3	ND/ND	ND	ND	0.0005	ND
	K-4	3	ND/ND	ND	ND	0.002	
66. bis(2-ethylhexyl)phthalate	B-1	1	0.001	0.001			
	B-4	1	0.001	0.006			0.010
	C-1	3	0.003	0.048	0.024	0.011	
	D-3	1	0.289	0.017			
	E-1	3	0.00066	0.00058	0.00044		
	E-2	3	0.00066	0.0017	0.00042	0.00063	0.0034
	E-3	3	0.00066	0.00085	0.002	0.00048	
	E-4	3	0.00066	0.0017	0.00064		
	F-1	3	0.001	0.003	0.020	0.009	
	F-2	3	0.001	0.004	0.003	0.002	
	F-6	3	0.001		0.063	0.033	
	G-1	3	ND	ND	1.72		
	H-1	1	*	0.134	0.085		0.196
	J-1	2	0.002	0.481			
	J-2	2	0.002	0.050			0.051
	K-2	3	0.005/0.113	0.240	0.258	1.006	
	K-3	3	0.005/0.161	0.072	0.107	0.314	0.122
	K-4	3	0.005/0.008	0.005	0.001	0.188	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
67. butyl benzyl phthalate	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND		
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	0.00049	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	0.006	0.004	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		*	ND	
	G-1	3	0.003	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
68. di-n-butyl phthalate	B-1	1	0.003	0.001			
	B-4	1	0.003	0.003			0.004
	C-1	3	*	0.003	0.003	0.001	
	D-3	1	0.003	0.012			
	E-1	3	0.000725	0.0091	0.00071		
	E-2	3	0.000725	0.0011	0.00043	0.00071	0.0010
	E-3	3	0.000725	0.0078	0.0014	0.0011	
	E-4	3	0.000725	0.0089	0.0017		
	F-1	3	*	0.001	0.003	0.003	
	F-2	3	*	0.003	0.002	0.003	
	F-6	3	*		*	*	
	G-1	3	ND	0.0010	0.0023		
	H-1	1	ND	ND	0.001		ND
	J-1	2	0.0105	0.013			
	J-2	2	0.0105	0.011			0.012
	K-2	3	0.005/ND	0.004	0.004	0.011	
	K-3	3	0.005/0.004	0.009	0.004	ND	0.005
	K-4	3	0.005/ND	0.006	0.007	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Source	Concentrations (mg/l) Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
69. di-n-octyl phthalate	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	0.004	0.004	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND		
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	0.00032	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	*	ND	0.002	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	0.005	ND	0.020		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	0.021	ND
	K-4	3	ND/ND	ND	ND	ND	
70. diethyl phthalate	B-1	1	*	0.002			
	B-4	1	*	*			*
	C-1	3	ND	*	*	ND	
	D-3	1	ND	ND			
	E-1	3	0.00082	0.00072	0.0011		
	E-2	3	0.00082	0.0013	0.00054	0.00074	0.00094
	E-3	3	0.00082	0.0011	0.0018	0.00080	
	E-4	3	0.00082	0.00074	0.0028		
	F-1	3	ND	*	ND	ND	
	F-2	3	ND	*	ND	ND	
	F-6	3	ND		*	ND	
	G-1	3	ND	0.621	0.964		
	H-1	1	ND	ND	ND		ND
	J-1	2	0.0005	ND			
	J-2	2	0.005	0.001			0.001
	K-2	3	ND/ND	ND	ND	*	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/*	ND	*	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Source	Day 1	Day 2	Day 3	Duplicate
				Concentrations (mg/l)			
Priority Pollutants (Continued)							
71. dimethyl phthalate	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND		ND
	E-2	3	ND	ND	ND	ND	
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	0.003	0.002	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.001	0.087		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/0.003	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
72. benzo(a)anthracene	B-1	1					
	B-4	1	ND	ND			ND
	C-1	3	ND	*	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	*	ND			
	E-3	3	ND	ND	ND	ND	ND
	E-4	3	ND	ND	0.00053	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	*	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
73. benzo(a)pyrene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	0.012			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	*	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	0.001			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/*	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
76. crysene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	*	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	0.004	0.004		0.004
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/0.004	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
78. anthracene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	*	*	*	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	0.00019	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	0.004	0.004	ND	
80. fluorene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	*	ND	
	D-3	1	*	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	0.00039	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
81. phenanthrene	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	*	*	*	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	0.00067	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
85. tetrachloroethylene	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	0.019	*	*	*	
	D-3	2	ND	ND			
	E-1	2	ND	ND		ND	
	E-2	2	ND	ND	ND	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	0.058	0.035		
	F-1	2	ND	ND	ND	ND	
	F-2	2	ND	ND	ND	ND	
	F-6	2	ND		ND	ND	
	G-1	2	0.012	0.004	0.014		
	H-1	2	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	0.001	ND			ND
	K-2	2	ND/ND	ND	ND	ND	
	K-3	2	ND/ND	ND	ND	ND	ND
	K-4	2	ND/ND	0.001/ND	ND/ND	ND/ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
86. toluene	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	*	0.006	0.005	0.002	
	D-3	2	ND	ND			
	E-1	2	ND	ND	ND		
	E-2	2	ND	0.0022	ND	ND	0.0025
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	0.00084	0.0011		
	F-1	2	*	*	*	*	
	F-2	2	*	0.008	0.015	0.002	
	F-6	2	*		0.002	*	
	G-1	2	ND	ND	ND		
	H-1	2	ND	ND	ND		ND
	J-1	2	0.012	ND			
	J-2	2	0.012	ND			ND
	K-2	2	ND/0.016	ND	ND	ND	
	K-3	2	ND/ND	ND	0.016	0.016	0.016
	K-4	2	ND/ND	ND/ND	ND/ND	ND/ND	
87. trichloroethylene	B-1	2	ND	ND			
	B-4	2	ND	ND			ND
	C-1	2	0.004	ND	*	ND	
	D-3	2	ND	ND			
	E-1	2	ND	ND		ND	
	E-2	2	ND	ND	0.0011	ND	ND
	E-3	2	ND	ND	ND	ND	
	E-4	2	ND	0.00062	ND		
	F-1	2	ND	ND	ND	ND	
	F-2	2	ND	ND	ND	ND	
	F-6	2	ND		ND	ND	
	G-1	2	0.343	0.146	0.215		
	H-1	2	ND	ND	ND		ND
	J-1	2	0.050	ND			
	J-2	2	0.050	0.003			0.002
	K-2	2	ND/ND	ND	ND	ND	
	K-3	2	ND/ND	0.001	ND	ND	ND
	K-4	2	ND/0.0095	0.001/ND	ND/ND	ND/ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Source	Concentrations (mg/l) Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
89. aldrin	B-1	1	ND	0.000003			
	B-4	1	ND	ND			ND
	C-1	3	**	**	**	ND	
	D-3	1	ND	ND			
	E-1	3	ND	0.000551	ND		
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	0.000702	ND		
	F-1	3	ND	0.0003	ND	ND	
	F-2	3	ND	**	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	0.000023
	K-4	3	ND/ND	ND/ND	ND/ND	ND/ND	
90. dieldrin	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	**	**	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	0.000086	ND	0.000034
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	0.000105	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	**	ND	**	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND/ND	ND/ND	ND/ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
92. 4,4'-DDT	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	0.000022	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND/ND	ND/ND	ND/ND	
93. 4,4'-DDE	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	0.000060		
	E-2	3	ND	ND	ND	ND	0.000027
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/0.000023	ND	ND	0.000045	ND
	K-4	3	ND/ND	ND/ND	ND/ND	ND/ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Codes§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
94. 4,4'-DDD	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	0.000040	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND/ND	ND/ND	ND/ND	
96. β-endosulfan	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	0.00014		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplica
Priority Pollutants (Continued)							
97. endosulfan sulfate	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	0.00013	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
98. endrin	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	**	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND		ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	**	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND	ND	ND	ND	
	K-3	3	ND	ND	ND	ND	ND
	K-4	3	ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Codes§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
99. endrin aldehyde	B-1	1					
	B-4	1	ND	0.000031			0.000066
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND			
	E-3	3	ND	ND	ND	ND	ND
	E-4	3	ND	ND	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND	ND	
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
100. heptachlor	B-1	1	0.000003	0.000002			
	B-4	1	0.000003	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	0.000243	0.000135		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	0.000026	0.000028	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
101. heptaclor expoxide	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	0.000382	ND		
	E-2	3	ND	ND	ND	0.00004	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/ND	ND	ND	ND	
	K-3	3	ND/ND	ND	ND	ND	ND
	K-4	3	ND/ND	ND	ND	ND	
102. α-BHC	B-1	1	0.000003	0.000005			
	B-4	1	0.000003	0.000004			0.000007
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	0.000121	0.000154	ND		
	E-2	3	0.000121	ND	ND	0.000108	ND
	E-3	3	0.000121	0.000182	0.000178	0.000194	
	E-4	3	0.000121	0.001208	0.00138		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	0.0006	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	0.000009		
	H-1	1	0.000002	0.000002	0.000003		0.000003
	J-1	2	0.0000025	0.00022			
	J-2	2	0.0000025	0.00029			ND
	K-2	3	0.000021/ 0.000008	0.000036	0.000134	0.000191	
	K-3	3	ND/0.000083	ND	0.000078	0.000113	ND
	K-4	3	ND/0.000076	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
103. β-BHC	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	0.0006	
	D-3	1	0.000181	0.00014			
	E-1	3	ND	ND		ND	
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	0.000166	ND	ND		
	H-1	1	0.000013	0.000016	ND		0.000012
	J-1	2	ND	ND			
	J-2	2	ND	ND			ND
	K-2	3	ND/0.000025	0.000062	0.000072	0.000335	
	K-3	3	0.000021/ 0.000046	0.000035	0.000047	0.000183	0.000043
	K-4	3	0.000021/ 0.000050	0.000025	0.000041	ND	
104. γ-BHC	B-1	1	ND	0.000002			
	B-4	1	ND	ND			ND
	C-1	3	ND	**	ND	ND	
	D-3	1	0.000006	0.000099			
	E-1	3	0.000110	0.000296	0.000076		
	E-2	3	0.000110	ND	0.000349	0.000057	ND
	E-3	3	0.00011	0.000122	ND	0.000096	
	E-4	3	0.00011	ND	ND		
	F-1	3	**	ND	ND	ND	
	F-2	3	**	ND	0.0003	ND	
	F-6	3	**		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		ND
	J-1	2	0.0000025	ND			
	J-2	2	0.0000025	ND			ND
	K-2	3	0.000018/ND	0.000032	0.000038	0.000076	
	K-3	3	ND/0.000027	0.000018	ND	0.000061	0.000022
	K-4	3	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
105. δ-BHC	B-1	1	0.000005	0.000009			
	B-4	1	0.000005	0.000005			0.000005
	C-1	3	**	**	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	0.000329		
	E-2	3	ND	ND	ND	ND	ND
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	0.000182	0.000352		
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	0.000006	0.000011	0.000135		0.000012
	J-1	2	0.0000085	0.000035			
	J-2	2	0.0000085	ND			ND
	K-2	3	ND/ND	ND	0.000039	ND	
	K-3	3	0.000018/ND	ND	0.000027	ND	ND
	K-4	3	0.000018/ND	0.000058	0.000061	0.000107	
114. antimony	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	0.002	0.002	0.004	0.003	
	E-2	3	0.002	0.002	0.004	0.003	
	E-3	3	0.002	ND	0.003	0.003	
	E-4	3	0.002	0.001	0.001	0.003	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/0.04	0.02	0.03	0.03	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
115. arsenic	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND	ND	
	E-2	3	ND	ND	ND	ND	
	E-3	3	ND	ND	ND	0.001	
	E-4	3	ND	ND	ND	0.001	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	ND	0.016			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	
117. beryllium	B-1	1	ND	ND			
	B-4	1	ND	ND			ND
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND	ND	
	E-2	3	ND	ND	ND	ND	
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.003	0.003		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
118. cadmium	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	0.025	0.019	0.015	
	D-3	1	ND	ND			
	E-1	3	0.005	0.004	0.005	0.005	
	E-2	3	0.005	0.006	0.005	0.006	
	E-3	3	0.005	0.006	0.003	0.006	
	E-4	3	0.005	0.003	0.005	0.004	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		0.053	0.071	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	0.018	0.014			
	J-2	2	0.018	0.017			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	
119. chromium	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	0.200	0.170	0.012	
	D-3	1	0.010	0.015			
	E-1	3	ND	ND	0.007	ND	
	E-2	3	ND	0.007	0.008	0.003	
	E-3	3	ND	0.009	0.008	ND	
	E-4	3	ND	0.008	0.003	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	0.073	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.143	0.077		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/0.02	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
120. copper	B-1	1	2.600	1.200			
	B-4	1	2.600	1.550			
	C-1	3	0.068	0.940	0.530	0.310	
	D-3	1	0.106	0.106			
	E-1	3	0.196	0.061	0.065	0.056	
	E-2	3	0.196	0.058	0.055	0.066	
	E-3	3	0.196	0.058	0.061	0.060	
	E-4	3	0.196	0.056	0.058	0.055	
	F-1	3	0.700	0.034	0.026	0.036	
	F-2	3	0.7	0.016	ND	ND	
	F-6	3	0.7		0.022	0.041	
	G-1	3	ND	0.06	0.045		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	0.037			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/0.1	0.05	0.1	0.1	
	K-4	3/1	ND/0.1	ND	ND	ND	
121. cyanide (total)	B-1	1	*	*			
	B-4	1	*	*			
	C-1	1	0	0	0	0	*
	D-3	1	<0.02	<0.02			
	E-1	1	*	*	*	*	<0.02
	E-2	1	*	*	*	*	
	E-3	1	*	*	*	*	
	E-4	1	*	*	*	*	
	F-1	1	<0.02	<0.02	<0.02	<0.02	
	F-2	1	<0.02	<0.02	<0.02	<0.02	
	F-6	1	<0.02		<0.02	<0.02	
	G-1	2	<0.02	<0.02	<0.02		
	H-1	1	*	*	*		
	J-1	2	*	*			*
	J-2	2	*	ND			
	K-2	1	<0.02/<0.02	<0.02	<0.02	<0.02	ND
	K-3	1	<0.02/<0.02	<0.02	<0.02	<0.02	
	K-4	1	<0.02/<0.02	<0.02	<0.02	<0.02	<0.02

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
122. lead	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	0.260	0.160	ND	
	D-3	1	ND	ND			
	E-1	3	0.080	0.071	0.061	0.060	
	E-2	3	0.080	0.122	0.292	0.126	
	E-3	3	0.080	0.057	0.059	0.064	
	E-4	3	0.080	ND	0.057	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/0.25	0.15	0.15	0.10	
	K-3	3/1	ND/0.05	0.1	ND	0.1	
	K-4	3/1	ND/ND	ND	ND	0.5	
123. mercury	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	0.0007	0.0003	0.0003	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND	ND	
	E-2	3	ND	ND	ND	ND	
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND	ND	ND	ND	
	K-3	3/1	ND	ND	ND	ND	
	K-4	3/1	ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Source	Concentrations (mg/l) Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
124. nickel	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	3.880	3.240	2.770	
	D-3	1	ND	ND			
	E-1	3	ND	0.013	0.017	ND	
	E-2	3	ND	0.012	0.021	ND	
	E-3	3	ND	0.021	0.014	ND	
	E-4	3	ND	0.010	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.073	ND		
	H-1	1	ND	ND	ND		
	J-1	2	ND	ND			
	J-2	2	ND	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	
125. selenium	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	0.002	0.001	0.002	0.001	
	E-2	3	0.002	0.001	0.002	0.001	
	E-3	3	0.002	0.002	ND	0.001	
	E-4	3	0.002	0.001	0.002	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	0.0345	0.012			
	J-2	2	0.0345	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Source	Concentrations (mg/l) Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
126. silver	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	0.012	0.0088	ND	
	D-3	1	ND	ND			
	E-1	3	0.001	0.002	0.001	ND	
	E-2	3	0.001	0.001	0.001	ND	
	E-3	3	0.001	0.001	ND	0.002	
	E-4	3	0.001	ND	0.001	0.001	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	ND	ND		
	H-1	1	ND	ND	ND		
	J-1	2	0.016	0.016			
	J-2	2	0.016	0.014			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	
127. thallium	B-1	1	ND	ND			
	B-4	1	ND	ND			
	C-1	3	ND	ND	ND	ND	
	D-3	1	ND	ND			
	E-1	3	ND	ND	ND	ND	
	E-2	3	ND	ND	ND	ND	
	E-3	3	ND	ND	ND	ND	
	E-4	3	ND	ND	ND	ND	
	F-1	3	ND	ND	ND	ND	
	F-2	3	ND	ND	ND	ND	
	F-6	3	ND		ND	ND	
	G-1	3	ND	0.126	0.126		
	H-1	1	ND	ND	ND		
	J-1	2	0.1385	ND			
	J-2	2	0.1385	ND			
	K-2	3/1	ND/ND	ND	ND	ND	
	K-3	3/1	ND/ND	ND	ND	ND	
	K-4	3/1	ND/ND	ND	ND	ND	

Table A-1 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CONTACT COOLING AND HEATING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
128. zinc	B-1	1	0.120	0.180			
	B-4	1	0.120	0.120			
	C-1	3	ND	0.750	0.770	0.490	
	D-3	1	0.017	0.018			
	E-1	3	1.46	0.691	0.755	0.687	
	E-2	3	1.46	0.627	0.658	0.637	
	E-3	3	1.46	0.664	0.662	0.712	
	E-4	3	1.46	0.624	0.64	0.59	
	F-1	3	0.015	ND	ND	ND	
	F-2	3	0.015	0.14	0.21	0.21	
	F-6	3	0.015		ND	ND	
	G-1	3	ND	0.067	0.125		
	H-1	1	ND	ND	ND		
	J-1	2	ND	0.054			
	J-2	2	ND	0.125			
	K-2	3/1	ND/0.08	0.06	0.06	0.08	
	K-3	3/1	ND/0.04	ND	0.04	0.04	
	K-4	3/1	ND/0.36	ND	ND	ND	

†Sample Type

1 - grab
2 - grab composite
3 - automatic composite

§See Figures VI-1 through VI-11.
††Value was not used because it was suspected to be result of laboratory contamination.
†††Pentachlorohenol was added to plant J's cooling tower as an algicide. Its use as an algicide was recently discontinued at plant J. For this reason, these data were not used in this project.
*Indicates a reported value that is <0.01 mg/l.
**Indicates a reported value that is <0.005 mg/l.

NA - Pollutant was not analyzed.

TABLE A-2

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Conventional Pollutants							
biological oxygen demand (BOD_5)	A-1	1	<5	9			
	A-2	1	<5	450			
	B-2	1	<5	<5			
	B-3	1	<5	48	46	52	
	C-2	1	83.8	84.8	48.5	72.7	
	D-1		NA	NA			
	D-2		NA	NA			
	F-3	1	2	510	247	52	
	F-4	1	2	198	34	26	
	I-1	1	1.7	6.3	6.1	6.2	
	I-2	1	1.7	2.6	5.95	5.65	
	I-3	1	1.7	3.2		6.6	
	K-1	2	<5	20			
oil and grease	A-1	2	<4	<4			
	A-2	2	<4	<4			
	B-2	2	<4	<4			
	B-3	2	<4	<4	<4	<4	
	C-2	1	17.0	31.0	0	17.5	
	D-1	2	<4	<4			
	D-2	2	<4	<4			
	F-3	1	3	548	684		
	F-4	1	3	3	89		
	I-1	1	0	18	7	44.7	
	I-2	1	0	234.5	21.8	174.1	
	I-3	1	0	21.2		7.8	
	K-1	2	<4	<4			
pH	A-1	1	8.6	9.2			
	A-2	1	8.6	1.6			
	B-2	1	5.6	5.5			
	B-3	3	6.8	7.1	7.1	6.2	
	C-2	3	5.8	6.85	6.25	6.55	
	D-1		NA	NA			
	D-2		NA	NA			
	F-3	3	7.6	7.9	8.1	8.0	
	F-4	3	7.6	7.9	8.5	8.4	
	I-1	3	6.6	7.2	7.5	7.5	
	I-2	1	6.6	11.5	10.0	10.8	
	I-3	1	6.6	11.0		8.0	
	K-1	2	8.0	9.3			

§See Figures VI-1 through VI-11.

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Codes	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Conventional Pollutants (Continued)							
total suspended solids (TSS)	A-1	1	8	12			
	A-2	1	8	39			
	B-2	1	<4	<4			
	B-3	3	<4	<4	<4	<4	
	C-2	3	0	8.0	2.0	11.0	
	D-1	1	<4	13			
	D-2	1	<4	8			
	F-3	3	2	198	274	466	
	F-4	3	2	90	1310	68	
	I-1	3	56.0	16363	11738	12597	
	I-2	1	56.0	5825	244	1039	
	I-3	1	56.0	1136		5671	
	K-1	2	<4	6			
Nonconventional Pollutants							
aluminum	A-1	1	ND	ND			
	A-2	1	ND	0.1			
	B-2	1	0.1	ND			
	B-3	1	0.2	0.2	0.2	0.1	
	C-2	3	ND	ND	ND	ND	
	D-1	1	0.11	0.07			
	D-2	1	0.11	ND			
	F-3	3	ND	0.1	0.058		
	F-4	3	ND	ND	0.071		
	I-1	3	0.2	0.2	0.1	0.2	
	I-2	1	0.2	8.1	0.3	5	
	I-3	1	0.2	4.2		5.2	
	K-1	2	ND	0.1			
ammonia nitrogen	A-1	1	<0.1	<0.1			
	A-2	1	<0.1	<0.1			
	B-2	1	0.06	<0.05			
	B-3	3	<0.05	0.06	0.06	0.17	
	C-2	3	0	0	9.52	5.60	
	D-1	1	<0.05	399			
	D-2	1	<0.05	198			
	F-3	1	3.3	<1	2.7	1.1	
	F-4	1	3.3	1.5	4.0	1.4	
	I-1	1	0.20	137.5	75.0	93.1	
	I-2	1	0.20	20.4	51.25	4.25	
	I-3	1	0.20	75.0		67.5	
	K-1	2	<0.05	0.66			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
barium	A-1	1	ND	0.014			
	A-2	1	ND	0.062			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	0.012	0.012	0.015	
	D-1	1	0.034	0.035			
	D-2	1	0.034	0.035			
	F-3	3	0.043	0.065	0.091		
	F-4	3	0.043	0.047	0.037		
	I-1	3	0.03	0.04	0.04	0.03	
	I-2	1	0.03	0.8	0.09	0.65	
	I-3	1	0.03	0.16		0.05	
	K-1	2	ND	ND			
boron	A-1	1	ND	ND			
	A-2	1	ND	0.024			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	0.050	0.034			
	D-2	1	0.050	0.053			
	F-3	3	0.051	0.19	0.18		
	F-4	3	0.051	0.14	0.15		
	I-1	3	0.050	0.06	0.12	0.06	
	I-2	1	0.050	0.23	0.07	0.21	
	I-3	1	0.050	0.52		0.58	
	K-1	2	ND	2.9			
bromide	A-1	1	<0.4	<0.4			
	A-2	1	<0.4	<0.4			
	B-2	1	<0.4	<0.4			
	B-3	3	<0.4	<0.4	<0.4	<0.4	
	C-2		NA	NA	NA	NA	
	D-1	1	<0.4	<0.4			
	D-2		NA	NA			
	F-3		NA	NA	NA	NA	
	F-4		NA	NA	NA	NA	
	I-1		NA	NA	NA	NA	
	I-2		NA	NA	NA	NA	
	I-3		NA	NA		NA	
	K-1	2	<0.4	<0.4			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
calcium	A-1	1	4.8	5.0			
	A-2	1	4.8	7.58			
	B-2	1	2.1	2.5			
	B-3	1	4.5	4.3	4.3	4.8	
	C-2	3	6.84	6.86	6.46	6.58	
	D-1	1	21.4	16.0			
	D-2	1	21.4	16.6			
	F-3	3	33.2	40.7	72.7		
	F-4	3	33.2	34.3	20.5		
	I-1	3	51.3	46.3	47.9	45.9	
	I-2	1	51.3	182.0	30.7	207.0	
	I-3	1	51.3	45.2		26.8	
	K-1	2	20.4	5.7			
chemical oxygen demand (COD)	A-1	1	19	460			
	A-2	1	19	958			
	B-2	1	<5	7			
	B-3	1	<5	96	86	62	
	C-2	3	0	453.9	278.5	148.8	
	D-1	1	<5	48			
	D-2	1	<5	172			
	F-3	3	8294	1321	261	983	
	F-4	3	8294	380	346	111	
	I-1	3	290	680	1150	640	
	I-2	1	290	480	520	560	
	I-3	1	290	200		950	
	K-1	2	<5	195			
cyanide (amenable)	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2		NA	NA			
	B-3		NA	NA	NA	NA	
	C-2	1	0	0	0	0	
	D-1		NA	NA			
	D-2	1	ND	ND			
	F-3	1	0	0	0	0	
	F-4	1	0	0	0	0	
	I-1	1	0.6	0.025	0.174	0.01	
	I-2	1	0.6	0	0.034	0	
	I-3	1	0.6	0		0.01	
	K-1		NA	NA			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
fluoride	A-1	1	0.20	0.19			
	A-2	1	0.20	6.8			
	B-2	1	1.2	0.88			
	B-3	3	0.44	0.12	0.37	0.11	
	C-2		NA	NA	NA	NA	
	D-1	1	0.95	0.99			
	D-2		NA	NA			
	F-3		NA	NA	NA	NA	
	F-4		NA	NA	NA	NA	
	I-1		NA	NA	NA	NA	
	I-2		NA	NA	NA	NA	
	I-3		NA	NA			
	K-1	2	0.81	0.27			
iron	A-1	1	0.171	1.95			
	A-2	1	0.171	2.20			
	B-2	1	0.3	0.45			
	B-3	1	0.1	0.1	0.05	0.05	
	C-2	3	0.14	1.44	1.15	1.25	
	D-1	1	ND	0.118			
	D-2	1	ND	ND			
	F-3	3	0.036	1.49	1.31		
	F-4	3	0.036	1.46	2.63		
	I-1	3	0.067	0.538	ND	0.269	
	I-2	1	0.067	51.3	0.023	39.1	
	I-3	1	0.067	10.6		4.73	
	K-1	2	ND	ND			
Kjeldahl nitrogen	A-1	1	<1	21.6			
	A-2	1	<1	<1			
	B-2	1	<1	<1			
	B-3	3	<1	<1	<1	<1	
	C-2	3	0	0	0	0	
	D-1	1	<1	361			
	D-2	1	<1	210			
	F-3	3	<0.02	7.55	3.7	2.5	
	F-4	3	<0.02	0.65	1.05	0.25	
	I-1	3	3.85	3070	1248	1718	
	I-2	1	3.85	45.5	1153	60.1	
	I-3	1	3.85	1310		1188	
	K-1	2	<1	12			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
magnesium	A-1	1	0.820	0.847			
	A-2	1	0.820	0.83			
	B-2	1	0.7	0.8			
	B-3	1	1.4	1.4	1.4	1.4	
	C-2	3	1.24	1.16	1.17	1.15	
	D-1	1	5.66	4.82			
	D-2	1	5.66	4.97			
	F-3	3	13.3	18.7	24.9		
	F-4	3	13.3	17.3	14.9		
	I-1	3	7.17	7.03	7.04	6.89	
	I-2	1	7.17	17.5	4.26	13.4	
	I-3	1	7.17	6.42		5.27	
	K-1	2	5.8	0.2			
manganese	A-1	1	ND	0.02			
	A-2	1	ND	0.176			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	0.072	0.070	0.072	0.071	
	D-1	1	0.008	0.01			
	D-2	1	0.008	0.003			
	F-3	3	ND	0.020	0.016		
	F-4	3	ND	0.011	0.024		
	I-1	3	ND	0.022	ND	ND	
	I-2	1	ND	0.519	ND	0.424	
	I-3	1	ND	0.111		0.084	
	K-1	2	ND	ND			
molybdenum	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	0.021	0.065		
	I-1	3	ND	ND	0.3	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
nitrate/nitrite	A-1	1	<0.1	<0.1			
	A-2	1	<0.1	<0.1			
	B-2	1	<0.1	0.1			
	B-3	3	0.25	0.25	0.20	0.28	
	C-2		NA	NA	NA	NA	
	D-1	1	2.0	2.1			
	D-2		NA	NA			
	F-3		NA	NA	NA	NA	
	F-4		NA	NA	NA	NA	
	I-1		NA	NA	NA	NA	
	I-2		NA	NA	NA	NA	
	I-3		NA	NA		NA	
	K-1	2	1.05	<0.1			
sodium	A-1	1	12.8	58.1			
	A-2	1	12.8	15.1			
	B-2	1	1.8	2.1			
	B-3	1	11.1	11.3	10.6	12.0	
	C-2	3	11.4	13.6	12.6	14.4	
	D-1	1	26.2	24.3			
	D-2	1	26.2	24.2			
	F-3	3	17.7	358	311		
	F-4	3	17.7	198	180		
	I-1	3	12.4	24.5	24.0	19.7	
	I-2	1	12.4	1830	3860	510	
	I-3	1	12.4	272		317	
	K-1	2	8.1	0.8			
sulfate	A-1	1	12	40			
	A-2	1	12	45			
	B-2	1	9	10			
	B-3	3	11	12	10	10	
	C-2		NA	NA	NA	NA	
	D-1	1	33	33			
	D-2		NA	NA			
	F-3		NA	NA	NA	NA	
	F-4		NA	NA	NA	NA	
	I-1		NA	NA	NA	NA	
	I-2		NA	NA	NA	NA	
	I-3		NA	NA		NA	
	K-1	2	10	<5			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
sulfide	A-1	1	<1	<1			
	A-2	1	<1	<1			
	B-2	1	<1	<1			
	B-3	1	<1	<1	<1	<1	
	C-2		NA	NA	NA	NA	
	D-1		NA	NA			
	D-2		NA	NA			
	F-3		NA	NA	NA	NA	
	F-4		NA	NA	NA	NA	
	I-1		NA	NA	NA	NA	
	I-2		NA	NA	NA	NA	
	I-3		NA	NA		NA	
	K-1	2	<0.01	<1			
surfactants	A-1	1	<0.01	20			
	A-2	1	<0.01	<0.01			
	B-2	1	<0.01	<0.01			
	B-3	3	<0.01	<0.01	<0.01	<0.01	
	C-2	3	0.08	0.92	0.04	1.06	
	D-1		NA	NA			
	D-2	1	ND	ND			
	F-3	3	<0.02	148	66	50	
	F-4	3	<0.02	0.05	0.15	0.07	
	I-1	3	0.15	0.10	0.112	0.05	
	I-2	1	0.15	0.05	0.40	0.025	
	I-3	1	0.15	0.15		0.112	
	K-1	2	<0.01	0.03			
tin	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	0.042	ND	0.021	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	0.077	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	1.1	
	I-2	1	ND	0.9	1.1	1.2	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
titanium	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	0.087	0.081	0.095	0.084	
	D-1	1	0.013	0.021			
	D-2	1	0.013	0.018			
	F-3	3	0.13	0.12	0.027		
	F-4	3	0.13	0.092	0.085		
	I-1	3	ND	0.016	ND	0.041	
	I-2	1	ND	0.199	ND	0.174	
	I-3	1	ND	0.06		0.075	
	K-1	2	ND	ND			
total dissolved solids (TDS)	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2		NA	NA			
	B-3		NA	NA	NA	NA	
	C-2	3	0	5.0	100	5.0	
	D-1		NA	NA			
	D-2	1	ND	ND			
	F-3	3	800	1300	1300	900	
	F-4	3	800	800	1400	600	
	I-1	3	201.5	221	227.5	214.5	
	I-2	1	201.5	4907.5	3250	1430	
	I-3	1	201.5	13000		812.5	
	K-1		NA	NA			
total organic carbon (TOC)	A-1	1	13	150			
	A-2	1	13	1010			
	B-2	1	6	7			
	B-3	3	5	36	34	39	
	C-2	1	3.0	74.0	19.5	30	
	D-1	1	2	22			
	D-2	1	2	56			
	F-3	1	37	875	455	242	
	F-4	1	37	70	103	52	
	I-1	1	11.0	9267	5412	10038	
	I-2	1	11.0	1472	3282	2604	
	I-3	1	11.0	5316		4998	
	K-1	2	3	58			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
total phenols	A-1	1	<20	<20			
	A-2	1	<20	50			
	B-2	1	<0.02	<0.02			
	B-3	1	<0.02	<0.02	<0.02	<0.02	
	C-2	1	1.42	0.1	20.86	1.42	
	D-1	1	<0.001	<0.001			
	D-2	1	<0.001	<0.001			
	F-3	1	10	32	82	222	
	F-4	1	10	30	62	16	
	I-1	1	2.7	2.95	3.13	3.75	
	I-2	1	2.7	585	575	284.5	
	I-3	1	2.7	730		0.83	
	K-1	2	<0.001	0.31			
total phosphorus	A-1	1	0.03	0.04			
	A-2	1	0.03	0.14			
	B-2	1	0.21	0.242			
	B-3	3	<0.02	0.052	<0.02	<0.02	
	C-2	3	1.2	<0.005	0.345	1.06	
	D-1	1	0.1	0.03			
	D-2	1	<0.1	<0.03			
	F-3	3	<0.02	10.5	23.85	13.4	
	F-4	3	<0.02	15.95	20.75	13.55	
	I-1	3	3.18	6.13	10.45	5.5	
	I-2	1	3.18	103.4	28.77	123	
	I-3	1	3.18	32.1		5.17	
	K-1	2	0.04	0.17			
vanadium	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	0.038	ND			
	D-2	1	0.038	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR CLEANING AND FINISHING WATER SUBCATEGORY (RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Source	Concentrations (mg/l) Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
yttrium	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND			
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	0.006	ND	ND	
	D-2	1	ND	0.006			
	F-3	3	ND	ND			
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND		
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND	ND	ND	
	K-1	2	ND	ND		ND	
Priority Pollutants							
4. benzene	A-1	2	0.005	0.006			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND			
	C-2	2	*	0.003	ND	ND	
	D-1	2	ND	0.018	*	*	
	D-2	2	ND	0.018			
	F-3	2	*	0.01			
	F-4	2	*	*	0.005		
	I-1	2	0.007	0.099	*		
	I-2	2	0.007	0.011	0.012	ND	
	I-3	2	0.007	0.01	0.012	0.009	
	K-1	2	ND	0.008		0.009	
6. carbon tetrachloride	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND			
	C-2	2	ND	ND	ND	ND	
	D-1	2	ND	ND	ND	ND	
	D-2	2	ND	ND			
	F-3	2	ND	ND			
	F-4	2	ND	ND	ND		
	I-1	2	ND	ND	ND		
	I-2	2	ND	ND	ND	ND	
	I-3	2	ND	ND	ND	ND	
	K-1	2	0.004	ND		ND	

TABLE A-2

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
7. chlorobenzene	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND	ND	ND	
	C-2	2	ND	ND	ND	ND	
	D-1	2	ND	ND			
	D-2	2	ND	0.0004			
	F-3	2	ND	ND	ND		
	F-4	2	ND	ND	*		
	I-1	2	ND	ND	ND	ND	
	I-2	2	ND	ND	ND	ND	
	I-3	2	ND	ND		ND	
	K-1	2	ND	ND			
11. 1,1,1-trichloroethane	A-1	2	0.003	*			
	A-2	2	0.003	0.010			
	B-2	2	*	0.0015			
	B-3	2	*	0.001	0.001	0.001	
	C-2	2	ND	ND	ND	ND	
	D-1	2	0.004	0.003			
	D-2	2	0.004	0.001			
	F-3	2	*	ND	ND		
	F-4	2	*	ND	ND		
	I-1	2	ND	ND	ND	ND	
	I-2	2	ND	0.011	0.010	0.020	
	I-3	2	ND	ND		ND	
	K-1	2	0.003	0.009			
13. 1,1-dichloroethane	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND	ND	ND	
	C-2	2	ND	ND	ND	ND	
	D-1	2	ND	ND			
	D-2	2	ND	ND			
	F-3	2	ND	ND	ND		
	F-4	2	ND	ND	ND		
	I-1	2	ND	ND	ND	ND	
	I-2	2	ND	ND	ND	ND	
	I-3	2	ND	0.003		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
22. p-chloro-m-cresol	A-1	1	0.042	0.042			
	A-2	1	0.042	0.042			
	B-2	1	0.008	0.008			
	B-3	3	0.008	0.005	0.008	0.008	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	0.014			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
23. chloroform	A-1	2	0.087	0.038			
	A-2	2	0.087	*			
	B-2	2	0.014	0.035			
	B-3	2	ND	ND	ND	ND	
	C-2	2	ND	ND	ND	ND	
	D-1	2	0.019	0.048			
	D-2	2	0.019	0.053			
	F-3	2	*	ND	*		
	F-4	2	*	ND	ND		
	I-1	2	0.12	0.013	0.007	ND	
	I-2	2	0.12	0.005	0.004	0.019	
	I-3	2	0.12	0.004		0.002	
	K-1	2	0.1015	ND			
24. 2-chlorophenol	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	0.006		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
26. 1,3-dichlorobenzene	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.001	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
30. 1,2-trans-dichloroethylene	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND	ND	ND	
	C-2	2	0.008	*	*	ND	
	D-1	2	ND	ND			
	D-2	2	ND	ND			
	F-3	2	ND	ND	ND		
	F-4	2	ND	ND	ND		
	I-1	2	ND	ND	ND	ND	
	I-2	2	ND	ND	ND	ND	
	I-3	2	ND	ND		ND	
	K-1	2	ND	ND			
31. 2,4-dichlorophenol	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	0.001		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
38. ethylbenzene	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND	ND	ND	
	C-2	2	ND	*	*	ND	
	D-1	2	ND	ND			
	D-2	2	ND	ND			
	F-3	2	ND	ND	0.001		
	F-4	2	ND	ND	ND		
	I-1	2	ND	ND	ND	ND	
	I-2	2	ND	ND	ND	ND	
	I-3	2	ND	ND		ND	
	K-1	2	ND	ND			
39. fluoranthene	A-1	1	*	*			
	A-2	1	*	*			
	B-2	1	ND	*			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	*	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	*			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.006	ND	0.002	
	I-3	1	ND	0.0004		ND	
	K-1	2	ND	ND			
44. methylene chloride	A-1	2	0.029	0.084			
	A-2	2	0.029	0.310			
	B-2	2	0.001	0.014			
	B-3	2	0.002	0.039	0.005	0.003	
	C-2	2	*	*	*	*	
	D-1	2	0.017	0.019			
	D-2	2	0.017	0.018			
	F-3	2	*	*	0.002		
	F-4	2	*	0.002	*		
	I-1	2	0.005	0.005	ND	0.016	
	I-2	2	0.005	0.005	0.005	ND	
	I-3	2	0.005	0.005		ND	
	K-1	2	0.015	0.032			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
47. bromoform	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND	ND	ND	
	C-2	2	ND	ND	ND	ND	
	D-1	2	ND	ND			
	D-2	2	ND	0.001			
	F-3	2	0.086	ND	0.010		
	F-4	2	0.086	0.004	ND		
	I-1	2	ND	ND	ND	ND	
	I-2	2	ND	ND	ND	ND	
	I-3	2	ND	ND		ND	
	K-1	2	ND	ND			
48. dichlorobromomethane	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	0.001			
	B-3	2	ND	ND	ND	ND	
	C-2	2	ND	ND	ND	ND	
	D-1	2	0.004	0.015			
	D-2	2	0.004	0.011			
	F-3	2	*	ND	ND		
	F-4	2	*	ND	ND		
	I-1	2	0.009	ND	ND	ND	
	I-2	2	0.009	ND	ND	ND	
	I-3	2	0.009	ND		ND	
	K-1	2	0.018	ND			
49. trichlorofluoromethane	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND	ND	ND	
	C-2	2	ND	0.017	0.034	0.017	
	D-1	2	ND	ND			
	D-2	2	ND	ND			
	F-3	2	ND	ND	ND		
	F-4	2	ND	0.003	*		
	I-1	2	ND	ND	ND	ND	
	I-2	2	ND	ND	ND	ND	
	I-3	2	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
51. chlorodibromomethane	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND	ND	ND	
	C-2	2	ND	ND	ND	ND	
	D-1	2	ND	0.001			
	D-2	2	ND	0.002			
	F-3	2	0.002	ND	ND		
	F-4	2	0.002	ND	ND		
	I-1	2	0.004	ND	ND	ND	
	I-2	2	0.004	ND	ND	ND	
	I-3	2	0.004	ND		ND	
	K-1	2	ND	ND			
55. naphthalene	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	*	ND			
	F-3	3	ND	*	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
56. nitrobenzene	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	*	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
57. 2-nitrophenol	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	*			
58. 4-nitrophenol	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	0.007	ND			
60. 4,6-dinitro-o-cresol	A-1	1	ND	ND			
	A-2	1	ND	0.004			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
62. N-nitrosodiphenylamine	A-1	1	0.001	0.001			
	A-2	1	0.001	0.028			
	B-2	1	ND	ND			
	B-3	3	ND	*	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	0.006			
	D-2	1	ND	0.006			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	0.005	0.064	
	I-3	1	ND	0.016		0.001	
	K-1	2	*	0.004			
64. pentachlorophenol	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	0.020	0.001	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
65. phenol	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	0.01	0.01			
	B-3	3	0.001	0.11	0.1	0.1	
	C-2	3	*	0.022	0.014	0.012	
	D-1	1	*	ND			
	D-2	1	*	ND			
	F-3	3	*	0.005	0.006		
	F-4	3	*	0.002	*		
	I-1	3	0.030	0.051	0.030	0.062	
	I-2	1	0.030	2.8	6.0	5.1	
	I-3	1	0.030	2.6		0.74	
	K-1	2	ND	0.214			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR CLEANING AND FINISHING WATER SUBCATEGORY (RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
66. bis(2-ethylhexyl)phthalate	A-1	1	ND	ND			
	A-2	1	ND	0.025			
	B-2	1	0.001	0.007			
	B-3	3	0.057	*	*	0.046	
	C-2	3	0.003	0.013	0.018	0.011	
	D-1	1	0.289	0.032			
	D-2	1	0.289	0.029			
	F-3	3	0.001	0.032	0.013		
	F-4	3	0.001	0.004	ND		
	I-1	3	0.001	0.002	0.004	0.140	
	I-2	1	0.001	0.080	0.001	0.062	
	I-3	1	0.001	0.004		0.007	
	K-1	2	0.005	0.083			
67. butyl benzyl phthalate	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	*	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	0.002	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
68. di-n-butyl phthalate	A-1	1	ND	ND			
	A-2	1	ND	0.002			
	B-2	1	0.003	0.008			
	B-3	3	0.001	0.003	0.003	0.003	
	C-2	3	*	0.002	0.003	*	
	D-1	1	0.003	0.008			
	D-2	1	0.003	0.008			
	F-3	3	*	*	0.023		
	F-4	3	*	*	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	0.001	ND	
	I-3	1	ND	ND		0.006	
	K-1	2	0.005	0.007			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Source	Day 1	Day 2	Day 3	Duplicate
			Concentrations (mg/l)				
Priority Pollutants (Continued)							
69. di-n-octyl phthalate	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	*	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
70. diethyl phthalate	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	*	0.001			
	B-3	3	ND	*	0.001	*	
	C-2	3	ND	*	*	*	
	D-1	1	ND	*			
	D-2	1	ND	0.001			
	F-3	3	ND	*	ND		
	F-4	3	ND	*	ND		
	I-1	3	ND	0.002	0.002	0.002	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	*			
72. benzo(a)anthracene	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	*	ND	ND	
	D-1	1	*	ND			
	D-2	1	*	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	0.001	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
73. benzo(a)pyrene	A-1	1	ND	ND			
	A-2	1	ND	*			
	B-2	1	ND	ND			
	B-3	3	ND	0.005	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
76. chrysene	A-1	1	0.004	0.004			
	A-2	1	0.004	0.004			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	*	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	0.001	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.005	ND	0.001	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
78. anthracene	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	*	*	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.008	ND	0.003	
	I-3	1	ND	ND		ND	
	K-1	2	ND	0.003			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
80. fluorene	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	*	ND	
	D-1	1	ND	ND			
	D-2	1	*	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
81. phenanthrene	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	*	*	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.008	ND	0.003	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
84. pyrene	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	*	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.006	ND	0.002	
	I-3	1	ND	0.0004		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
85. tetrachloroethylene	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND			
	C-2	2	0.019	*	ND	ND	
	D-1	2	ND	ND	0.003	*	
	D-2	2	ND	ND			
	F-3	2	ND	ND			
	F-4	2	ND	ND	ND		
	I-1	2	ND	ND	ND		
	I-2	2	ND	ND	ND	ND	
	I-3	2	ND	ND	ND	ND	
	K-1	2	ND	ND		ND	
86. toluene	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND			
	C-2	2	*	0.001	ND	ND	
	D-1	2	ND	0.036	0.001	*	
	D-2	2	ND	0.033			
	F-3	2	*	0.032			
	F-4	2	*	*	0.030		
	I-1	2	ND	0.002	*		
	I-2	2	ND	0.69	ND	0.003	
	I-3	2	ND	0.15	0.11	0.25	
	K-1	2	ND	ND		ND	
87. trichloroethylene	A-1	2	ND	ND			
	A-2	2	ND	ND			
	B-2	2	ND	ND			
	B-3	2	ND	ND			
	C-2	2	0.004	*	ND	ND	
	D-1	2	ND	0.001	ND	ND	
	D-2	2	ND	0.001			
	F-3	2	ND	ND			
	F-4	2	ND	ND	ND		
	I-1	2	ND	ND	ND		
	I-2	2	ND	ND	ND	0.003	
	I-3	2	ND	ND	ND	ND	
	K-1	2	ND	0.002		ND	

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
89. aldrin	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	0.000006	
	C-2	3	**	**	ND	0.0001	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	0.0001	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
90. dieldrin	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	**	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
97. endosulfan sulfate	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	**	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	**	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

.TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
98. endrin	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	0.00227	
	C-2	3	ND	**	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
100. heptachlor	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	0.000003	ND			
	B-3	3	ND	ND	ND	0.000004	
	C-2	3	ND	**	ND	0.0001	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	**	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
102. α-BHC	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	0.000003	0.000004			
	B-3	3	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	0.000004			
	D-2	1	ND	0.000006			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
103. β-BHC	A-1	1	0.000264	0.000005			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	3	0.000008	ND	0.00001	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	0.000181	ND			
	D-2	1	0.000181	ND			
	F-3	3	ND	0.0002	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	0.000021	ND			
104. γ-BHC	A-1	1	ND	ND			
	A-2	1	ND	0.000003			
	B-2	1	ND	ND			
	B-3	3	ND	ND	ND	0.000005	
	C-2	3	ND	**	ND	**	
	D-1	1	0.000006	ND			
	D-2	1	0.000006	ND			
	F-3	3	**	0.0016	ND		
	F-4	3	**	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	0.000002			
105. δ-BHC	A-1	1	0.000009	0.000015			
	A-2	1	0.000009	0.000033			
	B-2	1	0.000005	0.000006			
	B-3	3	0.000009	ND	ND	0.000013	
	C-2	3	**	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	0.0005	ND		
	F-4	3	ND	0.0002	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	0.000018	0.000008			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
114. antimony	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	0.009	ND	0.081	0.010	
	I-2	1	0.009	0.105	ND	0.133	
	I-3	1	0.009	0.035		0.019	
	K-1	2	ND	ND			
115. arsenic	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	0.080	0.095	0.050	0.004	
	I-2	1	0.080	0.040	0.120	0.010	
	I-3	1	0.080	0.080		0.080	
	K-1	2	ND	ND			
119. chromium	A-1	1	ND	ND			
	A-2	1	ND	0.077			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	0.049	ND	
	D-1	1	0.010	ND			
	D-2	1	0.010	0.013			
	F-3	3	ND	ND	0.030		
	F-4	3	ND	0.020	ND		
	I-1	3	ND	0.070	ND	ND	
	I-2	1	ND	0.510	ND	0.53	
	I-3	1	ND	0.12		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
120. copper	A-1	1	ND	0.054			
	A-2	1	ND	0.626			
	B-2	1	2.6	2.2			
	B-3	1	0.15	ND	ND	ND	
	C-2	3	0.068	0.055	0.028	0.046	
	D-1	1	0.106	0.207			
	D-2	1	0.106	0.156			
	F-3	3	0.700	0.045	0.055		
	F-4	3	0.700	0.021	0.042		
	I-1	3	ND	0.01	ND	0.01	
	I-2	1	ND	1.44	ND	0.91	
	I-3	1	ND	0.23		0.03	
	K-1	2	ND	0.85			
121. cyanide (total)	A-1	1	*	*			
	A-2	1	*	*			
	B-2	1	*	*			
	B-3	1	*	*	*	*	
	C-2	1	0	0	0	0	
	D-1	1	<0.02	<0.02			
	D-2	1	<0.02	<0.02			
	F-3	1	<0.02	<0.02	<0.02	<0.02	
	F-4	1	<0.02	<0.02	<0.02	<0.02	
	I-1	1	0.7	0.025	0.18	0.01	
	I-2	1	0.7	0	0.034	0	
	I-3	1	0.7	0		0.014	
	K-1	2	<0.02	<0.02			
122. lead	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	0.1	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	ND	ND	ND	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR
CLEANING AND FINISHING WATER SUBCATEGORY
(RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
123. mercury	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.0005	ND	0.0003	
	I-3	1	ND	0.0001		ND	
	K-1	2	ND	ND			
124. nickel	A-1	1	ND	ND			
	A-2	1	ND	0.166			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.110	ND	0.1	
	I-3	1	ND	ND		ND	
	K-1	2	ND	ND			
125. selenium	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	0.020	0.010	0.050	0.110	
	I-2	1	0.020	0.030	0.110	0.220	
	I-3	1	0.020	0.220		0.28	
	K-1	2	ND	ND			

TABLE A-2 (Continued)

SAMPLING DATA BY POLLUTANT FOR CLEANING AND FINISHING WATER SUBCATEGORY (RAW WASTEWATER)

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
126. silver	A-1	1	ND	ND			
	A-2	1	ND	ND			
	B-2	1	ND	ND			
	B-3	1	ND	ND	ND	ND	
	C-2	3	ND	ND	ND	ND	
	D-1	1	ND	ND			
	D-2	1	ND	ND			
	F-3	3	ND	ND	ND		
	F-4	3	ND	ND	ND		
	I-1	3	ND	ND	ND	ND	
	I-2	1	ND	0.018	ND	0.006	
	I-3	1	ND	0.002		ND	
	K-1	2	ND	ND			
128. zinc	A-1	1	ND	0.108			
	A-2	1	ND	0.71			
	B-2	1	0.12	0.16			
	B-3	1	0.06	0.02	ND	0.02	
	C-2	3	ND	0.12	0.080	0.10	
	D-1	1	0.017	0.033			
	D-2	1	0.017	0.027			
	F-3	3	0.015	0.38	0.45		
	F-4	3	0.015	0.029	0.20		
	I-1	3	1.13	0.253	0.99	0.269	
	I-2	1	1.13	29.8	0.583	17.0	
	I-3	1	1.13	11.9		0.43	
	K-1	2	ND	0.16			

†Sample Type

1 - grab
2 - grab composite
3 - automatic composite

§See Figures VI-1 through VI-11.
*Indicates a reported value that is <0.01 mg/l.
**Indicates a reported value that is <0.005 mg/l.

NA - Pollutant was not analyzed.

TABLE A-3

SAMPLING DATA BY POLLUTANT FOR WASTEWATER TREATMENT SYSTEM ONE (PLANT I)

Pollutant	Process Code†	Sample Type††	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Conventional Pollutants							
biological oxygen demand (BOD_5)	I-3	1	1.7	3.2	6.6		
	I-5	1	1.7	5.1	1.6	4.4	
oil and grease	I-3	1	0	21.2	7.8		
	I-5	1	0	13.4	11.6	8.3	
pH	I-3	1	6.6	11.0	8.0		
	I-5	1	6.6	11.1	8.0	9.0	
total suspended solids (TSS)	I-3	1	56	1136	5671		
	I-5	1	56	356	305	329	
Nonconventional Pollutants							
aluminum	I-3	1	0.2	4.2	5.2		
	I-5	1	0.2	0.4	0.4	0.3	
ammonia nitrogen	I-3	1	0.2	75.0	67.5		
	I-5	1	0.2	95	40.3	166.2	
barium	I-3	1	0.03	0.16	0.05		
	I-5	1	0.03	0.07	0.07	ND	
boron	I-3	1	0.05	0.52	0.58		
	I-5	1	0.05	0.061	0.07	0.20	
calcium	I-3	1	51.3	45.2	26.8		
	I-5	1	51.3	36.0	31.5	7.23	
chemical oxygen demand (COD)	I-3	1	290	200	950		
	I-5	1	290	320	880	600	
cyanide amenable	I-3	1	0.6	0	0.01		
	I-5	1	0.6	0.021	0.021	0.022	
iron	I-3	1	0.067	10.6	4.73		
	I-5	1	0.067	0.404	0.202	0.224	

TABLE A-3 (Continued)

SAMPLING DATA BY POLLUTANT FOR
WASTEWATER TREATMENT SYSTEM ONE
(PLANT I)

Pollutant	Process Code†	Sample Type††	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
Kjeldahl nitrogen	I-3	1	3.85	1310	1188		
	I-5	1	3.85	1377	84.7	4750	
magnesium	I-3	1	7.17	6.42	5.27		
	I-5	1	7.17	3.28	49.3	1.12	
manganese	I-3	1	ND	0.111	0.084		
	I-5	1	ND	ND	ND	ND	
sodium	I-3	1	12.4	272	317		
	I-5	1	12.4	3970	2320	958	
surfactants	I-3	1	0.15	0.15	0.112		
	I-5	1	0.15	0.70	0.125	0.07	
tin	I-3	1	ND	ND	ND		
	I-5	1	ND	ND	ND	0.8	
titanium	I-3	1	ND	0.060	0.075		
	I-5	1	ND	ND	ND	ND	
total dissolved solids (TDS)	I-3	1	201.5	13000	812.5		
	I-5	1	201.5	4517.5	3315	1950	
total organic carbon (TOC)	I-3	1	11.0	5316	4998		
	I-5	1	11.0	2813	4628	5250	
total phenols	I-3	1	2.7	730	0.83		
	I-5	1	2.7	322	591	0.72	
total phosphorus	I-3	1	3.18	32.1	5.17		
	I-5	1	3.18	99.6	224	45.2	
vanadium	I-3	1	ND	ND	ND		
	I-5	1	ND	0.022	0.022	0.022	
Priority Pollutants							
4. benzene	I-3	2	0.007	0.01	0.009		
	I-5	2	0.007	0.009	0.010	0.003	0.010

TABLE A-3 (Continued)

SAMPLING DATA BY POLLUTANT FOR
WASTEWATER TREATMENT SYSTEM ONE
(PLANT I)

Pollutant	Process Code†	Sample Type††	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
11. 1,1,1-trichloroethane	I-3	2	ND	ND	ND		
	I-5	2	ND	0.002	0.003	ND	ND
15. 1,1,2,2-tetrachloroethane	I-3	2	ND	ND	ND		
	I-5	2	ND	ND	ND	ND	0.002
21. 2,4,6-trichlorophenol	I-3	1	ND	ND	ND		
	I-5	1	ND	0.001	0.0005	ND	0.002
23. chloroform	I-3	2	0.12	0.004	0.002		
	I-5	2	0.12	ND	0.007	0.010	0.006
24. 2-chlorophenol	I-3	1	ND	0.006	ND		
	I-5	1	ND	0.014	0.005	0.002	0.009
31. 2,4-dichlorophenol	I-3	1	ND	0.001	ND		
	I-5	1	ND	0.005	0.002	ND	0.006
39. fluoranthene	I-3	1	ND	0.004	ND	ND	
	I-5	1	ND	ND	ND	ND	ND
44. methylene chloride	I-3	2	0.005	0.005	ND		
	I-5	2	0.005	0.010	ND	ND	ND
48. dichlorobromomethane	I-3	2	0.009	ND	ND		
	I-5	2	0.009	ND	ND	ND	ND
51. chlorodibromomethane	I-3	2	0.004	ND	ND		
	I-5	2	0.004	ND	ND	ND	ND
62. N-nitrosodiphenylamine	I-3	1	ND	0.016	0.001		
	I-5	1	ND	0.004	0.004	0.006	0.003
64. pentachlorophenol	I-3	1	ND	ND	ND		
	I-5	1	ND	0.002	ND	ND	0.001
65. phenol	I-3	1	0.030	2.6	0.74		
	I-5	1	0.030	7.7	2.0	1.5	2.7
66. bis(2-ethylhexyl)phthalate	I-3	1	0.001	0.004	0.007		
	I-5	1	0.001	0.0007	0.006	0.012	0.003

TABLE A-3 (Continued)

SAMPLING DATA BY POLLUTANT FOR WASTEWATER TREATMENT SYSTEM ONE (PLANT I)

Pollutant	Process Code†	Sample Type††	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
68. di-n-butyl phthalate	I-3	1	ND	ND	0.006		
	I-5	1	ND	0.002	0.002	0.002	0.004
84. pyrene	I-3	1	ND	0.0004	ND		
	I-5	1	ND	ND	ND	ND	ND
86. toluene	I-3	2	ND	0.15	ND		
	I-5	2	ND	0.11	0.039	0.032	0.103
114. antimony	I-3	1	0.009	0.035	0.019		
	I-5	1	0.009	0.141	0.038	0.087	
115. arsenic	I-3	1	0.080	0.080	0.080		
	I-5	1	0.080	0.095	0.22	0.036	
119. chromium	I-3	1	ND	0.12	ND		
	I-5	1	ND	ND	ND	ND	
121. cyanide (total)	I-3	1	0.700	0	0.014		
	I-5	1	0.700	0.024	0.017	0.018	
123. mercury	I-3	1	ND	0.0001	ND		
	I-5	1	ND	ND	ND	0.0001	
124. nickel	I-3	1	ND	ND	ND		
	I-5	1	ND	ND	ND	0.110	
125. selenium	I-3	1	0.020	0.220	0.28		
	I-5	1	0.020	0.110	0.090	0.16	
126. silver	I-3	1	ND	0.002	ND		
	I-5	1	ND	ND	ND	ND	

††Sample Type

1 - grab
2 - grab composite

†I-3 is influent, I-5 is effluent; see Figure VI-9.

TABLE A-4

SAMPLING DATA BY POLLUTANT FOR
WASTEWATER TREATMENT SYSTEM TWO
(PLANT I)

Pollutant	Process Code†	Sample Type††	Concentrations (mg/l) Source	Day I	Day 2	Day 3	Duplicate
Conventional Pollutants							
biological oxygen demand (BOD_5)	I-4	3	0.75	3.8	6.4	5.7	
	I-6	1	0.75	2.65	3.8	5.6	
oil and grease	I-4	1	0	2.4	2.0	19.7	
	I-6	1	0	0	0	0	
pH	I-4	3	7.8	8.4	8.0	8.4	
	I-6	1	7.8	9.1	6.5	7.5	
total suspended solids (TSS)	I-4	3	33	63	289	1359	
	I-6	1	33	12	7	0	
Nonconventional Pollutants							
aluminum	I-4	3	0.200	6.7	9.75	10.9	
	I-6	1	0.200	0.200	0.200	0.300	
ammonia nitrogen	I-4	3	0.45	0.25	57.5	3.0	
	I-6	1	0.45	0.38	0.35	0	
barium	I-4	3	0.030	0.030	0.040	0.030	
	I-6	1	0.030	0.030	ND	0.030	
boron	I-4	3	0.700	0.700	0.590	0.620	
	I-6	1	0.700	0.520	0.520	0.730	
calcium	I-4	3	7.04	12.4	13.6	11.3	
	I-6	1	7.04	17.1	11.6	11.4	
chemical oxygen demand (COD)	I-4	3	225	170	325	290	
	I-6	1	225	125	295	40	
cyanide amenable	I-4	3	0	0.013	0	0.013	
	I-6	1	0	0.008	0.006	0.006	
iron	I-4	3	0.247	5.04	8.61	9.66	
	I-6	1	0.247	0.089	0.314	0.089	

TABLE A-4 (Continued)

SAMPLING DATA BY POLLUTANT FOR
WASTEWATER TREATMENT SYSTEM TWO
(PLANT I)

Pollutant	Process Code†	Sample Type††	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
Kjeldahl nitrogen	I-4	3	8.55	4.5	1380	51.9	
	I-6	1	8.55	7.22	6.2	1.76	
magnesium	I-4	3	3.05	3.58	3.82	3.63	
	I-6	1	3.05	3.76	3.24	3.22	
manganese	I-4	3	0.009	0.084	0.064	0.152	
	I-6	1	0.009	0.016	ND	ND	
sodium	I-4	3	359	317	318	326	
	I-6	1	359	291	325	328	
surfactants	I-4	3	0.25	0.20	0.20	0.30	
	I-6	1	0.25	0.15	0.15	0.10	
tin	I-4	3	ND	ND	ND	ND	
	I-6	1	ND	1.9	ND	ND	
titanium	I-4	3	0.010	0.054	0.076	0.076	
	I-6	1	0.010	ND	ND	ND	
total dissolved solids (TDS)	I-4	3	981.5	1040	910	910	
	I-6	1	981.5	715	897	981.5	
total organic carbon (TOC)	I-4	3	1.7	11.2	27.0	238	
	I-6	1	1.7	25.2	1.3	5.6	
total phenols	I-4	3	4.5	2.55	8.75	1.22	
	I-6	1	4.5	15.10	0.08	4.93	
total phosphorus	I-4	3	0.52	0.10	0.96	1.94	
	I-6	1	0.52	4.22	1.06	0	
vanadium	I-4	3	ND	ND	ND	0.006	
	I-6	1	ND	ND	ND	ND	
Priority Pollutants							
4. benzene	I-4	2	0.003	ND	0.009	0.007	
	I-6	2	0.003	0.008	0.008	ND	

TABLE A-4 (Continued)

SAMPLING DATA BY POLLUTANT FOR
WASTEWATER TREATMENT SYSTEM TWO
(PLANT I)

Pollutant	Process Code†	Sample Type††	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
11. 1,1,1-trichloroethane	I-4	2	ND	0.018	ND	ND	
	I-6	2	ND	ND	ND	ND	
44. methylene chloride	I-4	2	0.009	ND	0.006	ND	
	I-6	2	0.009	0.004	0.014	ND	
65. phenol	I-4	3	0.081	0.014	0.073	0.200	
	I-6	1	0.081	0.016	0.250	0.130	
66. bis(2-ethylhexyl)phthalate	I-4	3	ND	0.005	0.040	0.014	
	I-6	1	ND	0.020	0.002	ND	
68. di-n-butyl phthalate	I-4	3	ND	0.014	ND	0.017	
	I-6	1	ND	ND	0.012	ND	
69. di-n-octyl phthalate	I-4	3	ND	ND	ND	ND	
	I-6	1	ND	ND	0.053	ND	
70. diethyl phthalate	I-4	3	ND	ND	ND	ND	
	I-6	1	ND	ND	0.0009	ND	
86. toluene	I-4	2	ND	ND	ND	ND	
	I-6	2	ND	0.001	ND	ND	
114. antimony	I-4	3	ND	ND	0.010	0.010	
	I-6	1	ND	ND	0.005	0.009	
115. arsenic	I-4	3	0.100	0.110	0.110	0.010	
	I-6	1	0.100	0.095	0.110	0.018	
119. chromium	I-4	3	ND	ND	0.010	0.010	
	I-6	1	ND	ND	ND	ND	
120. copper	I-4	3	ND	ND	0.020	0.010	
	I-6	1	ND	ND	ND	ND	
121. cyanide (total)	I-4	1	0	0.015	0	0.013	
	I-6	1	0	0.008	0.006	0.006	
123. mercury	I-4	3	ND	0.0002	ND	0.0001	
	I-6	1	ND	ND	0.0001	0.0004	

TABLE A-4 (Continued)

SAMPLING DATA BY POLLUTANT FOR
WASTEWATER TREATMENT SYSTEM TWO
(PLANT I)

Pollutant	Process Code†	Sample Type††	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
124. nickel	I-4	3	ND	0.040	ND	0.040	
	I-6	1	ND	ND	0.040	ND	
125. selenium	I-4	3	0.060	0.200	0.300	0.280	
	I-6	1	0.060	0.160	0.060	0.090	
128. zinc	I-4	3	ND	0.084	0.229	0.176	
	I-6	1	ND	0.015	ND	ND	

††Sample Type

1 - grab
2 - grab composite
3 - automatic composite

†I-4 is influent, I-6 is effluent; see Figure VI-9.

TABLE A-5

SOLVENT RECOVERY WASTEWATER DATA - PLANT G

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l)				
			Source	Day 1	Day 2	Day 3	Duplicate
Conventional Pollutants							
biological oxygen demand (BOD_5)	G-2	3	<5.0	7.0	††	††	10.0
oil and grease	G-2	2	6.0	8.0	8.0	<4.0	<4.0
pH	G-2	2	7.4	3.6	3.6	3.6	3.6
total suspended solids	G-2	3	16.0	14.0	14.0	<4.0	18.0
Nonconventional Pollutants							
acetone	G-2	3	NA	0.020	0.077	0.144	0.027
ammonia nitrogen	G-2	3	<0.05	<0.05	0.19	0.05	<0.05
boron	G-2	3	ND	0.042	ND	ND	
bromide	G-2	3	0.56	<0.4	<0.4	0.8	<0.4
calcium	G-2	3	0.062	0.041	0.144	0.044	
chemical oxygen demand (COD)	G-2	3	<5.0	435	465	482	470
fluoride	G-2	3	0.46	0.13	0.18	0.25	0.18
iron	G-2	3	ND	1.009	0.886	0.862	
Kjeldahl nitrogen	G-2	3	<1.0	<1.0	<1.0	<1.0	<1.0
magnesium	G-2	3	0.181	0.163	0.17	0.167	
nitrate/nitrite	G-2	3	5.8	<0.1	0.2	<0.1	<0.1
sodium	G-2	3	ND	ND	ND	ND	
sulfate	G-2	2	1040	<5.0	<5.0	<5.0	<5.0
sulfide	G-2	3	<1.0	<1.0	<1.0	<1.0	<1.0
surfactants	G-2	3	<0.01	<0.01	0.02	0.03	<0.01

TABLE A-5 (Continued)

SOLVENT RECOVERY WASTEWATER DATA - PLANT G

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Nonconventional Pollutants (Continued)							
titanium	G-2	3	0.01	ND	0.008	0.011	
total organic carbon (TOC)	G-2	3	<1.0	165	179	174	178
total phenols	G-2	2	0.023	0.170	0.19	0.15	0.150
total phosphorus	G-2	3	0.04	0.04	0.04	<0.02	0.04
vanadium	G-2	3	ND	0.046	ND	ND	
yttrium	G-2	3	ND	ND	ND	ND	
Priority Pollutants							
1. acenaphthene	G-2	3	ND	ND	0.094	ND	ND
6. carbon tetrachloride	G-2	2	0.001	ND	0.018	ND	ND
11. 1,1,1-trichloroethane	G-2	2	0.004	0.001	0.002	0.001	0.001
18. bis(2-chloroethyl)ether	G-2	3	ND	0.001	ND	ND	0.003
23. chloroform	G-2	2	0.006	0.002	0.004	0.001	0.002
44. methylene chloride	G-2	2	0.001	0.008	0.026	0.007	0.008
47. bromoform	G-2	2	ND	ND	*	ND	*
62. N-nitrosodiphenylamine	G-2	3	ND	ND	*	*	ND
65. phenol	G-2	3	ND	0.011	*	0.090	ND
66. bis(2-ethylhexyl)phthalate	G-2	3	0.015	0.005	0.003	0.004	0.116
68. di-n-butyl phthalate	G-2	3	0.003	0.007	0.012	0.008	0.003
70. diethyl phthalate	G-2	3	0.005	0.136	0.439	0.177	ND
71. dimethyl phthalate	G-2	3	ND	0.002	0.0730	.043	ND

TABLE A-5 (Continued)

SOLVENT RECOVERY WASTEWATER DATA - PLANT G

Pollutant	Process Code§	Sample Type†	Concentrations (mg/l) Source	Day 1	Day 2	Day 3	Duplicate
Priority Pollutants (Continued)							
72. benzo(a)anthracene	G-2	3	ND	*	*	*	ND
73. benzo(a)pyrene	G-2	3	ND	*	0.002	*	0.002
80. fluorene	G-2	3	ND	ND	*	ND	ND
84. pyrene	G-2	3	ND	ND	ND	*	ND
85. tetrachloroethylene	G-2	2	0.012	ND	ND	ND	ND
86. toluene	G-2	3	ND	ND	ND	ND	0.001
87. trichloroethylene	G-2	2	0.343	ND	ND	0.001	ND
100. heptachlor	G-2	3	ND	0.000150	ND	ND	ND
101. heptachlor epoxide	G-2	3	ND	ND	0.000084	ND	ND
102. α-BHC	G-2	3	ND	ND	ND	0.000006	ND
103. β-BHC	G-2	3	0.000166	0.000225	ND	ND	0.000011
120. copper	G-2	3	ND	0.037	0.086	0.072	
121. cyanide (total)	G-2	2	<0.02	<0.02	<0.02	<0.02	<0.02
128. zinc	G-2	3	ND	0.026	0.004	ND	

†Sample Type

2 - grab composite
3 - automatic composite

§See Figures VI-7.
††Value not used because it was suspected to be result of laboratory contamination.
*Indicates a reported value that is <0.01 mg/l.

APPENDIX B

STATE INDUSTRIAL GUIDES

APPENDIX B

STATE INDUSTRIAL GUIDES

Appendix B lists the State Industrial Guides used to estimate the size of the PM&F category. This estimate is described in Section IV.

State	Edition	Title and Publisher
Alabama	1980-81	Alabama Director of Mining and Manufacturing, Industrial Research Department, Alabama Development Office
Arizona	1982	Arizona Directory of Manufacturers, Pheonix Metropolitan Chamber of Commerce
Arkansas	1982	Arkansas Directory of Manufacturers, Arkansas Industrial Development Foundation
California	1983	California Manufacturer's Register, California Manufacturer's Association
Colorado	1982	Directory of Colorado Manufacturers, University of Colorado, Boulder, Business Division, College of Business and Administration
Connecticut	1982	MacRae's Connecticut State Industrial Directory
Delaware	1981-82	Delaware Directory of Commerce and Industry, Delaware State Chamber of Commerce
Florida	1982	Directory of Florida Industries, The Florida Chamber of Commerce c 1981
Georgia	1980-81	Georgia Manufacturing Directory, Georgia Department of Industry and Trade, c. 1980

State	Edition	Title and Publisher
Idaho	1982	Idaho Manufacturing Directory University of Idaho Center for Business Development and Research
Illinois	1983	Illinois Manufacturers Directory, Manufacturer's News Inc., Chicago, IL Editor, Louise M. West
Indiana	1983	Harris Indiana Marketer's Industrial Directory, Harris Publishing Company (1983, Ohio), State Directory Division
Iowa	1981-82	Directory of Iowa Manufacturers, Iowa Development Commission
Kansas	1981-82	Directory of Kansas Manufacturers and Products, Kansas Department of Economic Development
Kansas	1981-82	Directory of Kansas Manufacturers and Products, Kansas Economic Development Commission
Kentucky	1983	Kentucky Directory of Manufacturers, Kentucky Department of Economic Development
Louisiana	1982	Directory of Louisiana Manufacturers, Louisiana Department of Commerce
Maine	1981-82	Directory of New England Manufacturers, New England Council, George D. Hall Company
Maryland	1981-82	The Directory of Maryland Manufacturers, State of Maryland, Department of Economic and Community Development
Massachusetts	1981-82	Directory of Massachusetts Manufacturers, George D. Hall's Association Industires of Mass c. 1981
Michigan	1982	The Directory of Michigan Manufacturers, Pick Publications, Inc.
Minnesota	1981	Minnesota Directory of Manufacturers, Minnesota Department of Economic Development

State	Edition	Title and Publisher
Mississippi	1980	*Mississippi Manufacturers Directory* Mississippi Research and Development Center, printed 1979
Missouri	1982	*Missouri Directory*, *Mining and Manufacturing Industires Services and Supplies*, Information Data Company
Nebraska	1982-83	*A Directory of Nebraska Manufacturers and Their Products*, Nebraska Department of Economic Development
Nevada	1981	*Nevada Industrial Directory*, Nevada Department of Economic Development
New Hampshire	1982-83	*Made in New Hampshire*, State of New Hampshire, Office of Industrial Development, Division of Economic Development
New Jersey	1983	*New Jersey State Industrial Directory* MacRae's Blue Book, Inc.
New York	1983	*New York State Industrial Directory*, MacRae's Blue Book, Inc. Editor, Barbara Sadic
North Carolina	1981-82	*Directory of North Carolina Manufacturing Firms*, North Carolina Department of Commerce
North Dakota	1978-79	*Directory of North Dakota Manufacturing*, North Dakota Business and Industrial Development Department
Ohio	1983	*Ohio Marketers Industrial Directory*, Harris Publishing Company
Oklahoma	1980	*Oklahoma Directory of Manufacturers and Products*, Industrial Development Department
Pennsylvania	1982	*MacRae's Pennsylvania State Industrial Directory*
Rhode Island	1981-82	*Rhode Island Directory of Manufacturers*, Rhode Island Directory of Economic Development

State	Edition	Title and Publisher
South Carolina	1983	South Carolina 1983 Industrial Directory, South Carolina State Development Board
South Dakota	1981-82	South Dakota Manufacturers & Processors Directory, Department of Economic and Tourism Development
Tennessee	1982	Tennessee Directory of Manufacturers, Tennessee Department of Economic and Community Development
Texas	1983	Directory of Texas Manufacturers, Bureau of Business Research, University of Texas, Austin
Virginia	1981-82	Virginia Industrial Directory, Virginia State Chamber of Commerce
Washington	1982-83	Washington Manufacturers Register, Times Mirror Press, Washington State Department of Commerce and Economic Development
West Virginia	1980	West Virginia Manufacturer's Directory, Governor's Office of Economic and Community Development Department
Wisconsin	1983	Classified Directory of Wisconsin Manufacturers, Wisconsin Association of Manufacturers and Commerce

APPENDIX C

BENEFITS

APPENDIX C

BENEFITS

This appendix explains how benefits (i.e., amount of pollutants removed) were calculated for the BPT options. The BPT effluent limitations guidelines apply only to direct dischargers. The amount of pollutants generated by direct dischargers is 44 percent of the total pollutant mass for the contact cooling and heating water subcategory and 32 percent of the total pollutant mass for the cleaning and finishing water subcategory. These percentages represent the percentage of direct dischargers of the total number of direct and indirect dischargers in the questionnaire data base; they were multiplied by the total mass of pollutants generated by the PM&F category (see Table VII-7) to determine the pollutant mass for direct dischargers. The pollutant mass for indirect dischargers is the difference between the total and direct discharge mass. Table C-1 lists the total pollutant mass for the direct and indirect dischargers by subcategory.

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Option 1

The technology for Option 1 consists of a tank in which the velocity of the wastewater is reduced so that solid material can settle by gravitational force. There are no benefits for this option because the suspended solids concentration in the contact cooling and heating water is very low and because the technology does not remove the dissolved pollutants (e.g., biochemical oxygen demand). The pollutant masses remaining after treatment are equal to the total pollutant masses for direct dischargers listed in Table C-1.

Option 2

The technology for this option consists of zero discharge by 100 percent recycle of the process water using either a tank or a chiller for processes with an average process water flow rate of 35 gpm or less.

For processes with an average process water flow rate greater than 35 gpm the technology is recycle through a cooling tower and treatment of the recycle unit discharge in a package activated sludge plant. An equalization unit is included in the package activated sludge plant.

Table C-1

TOTAL CATEGORY POLLUTANT MASS DISTRIBUTED BY DISCHARGE MODE

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Conventional Pollutants	Direct Dischargers Pollutant Mass (kg/yr)	Indirect Dischargers Pollutant Mass (kg/yr)
BOD_5	7,920,000	10,080,000
Oil and Grease	708,000	902,000
TSS	295,000	375,000
TOTAL	8,923,000	11,357,000
Nonconventional Pollutants		
COD	19,400,000	24,700,000
TOC	7,610,000	9,690,000
Total Phenols	233,000	296,000
TOTAL	27,243,000	34,686,000
Priority Pollutants		
4. benzene	4,390	5,590
6. carbon tetrachloride (tetrachloromethane)	60,300	76,700
11. 1,1,1-trichloroethane	6,200	7,900
22. parachlorometa cresol	2,020	2,580
23. chloroform (trichloromethane)	4,840	6,160
44. methylene chloride (dichloromethane)	5,680	7,220
65. phenol	1,610	2,060
66. bis(2-ethylhexyl) phthalate	30,200	38,500
68. di-n-butyl phthalate	1,290	1,650
85. tetrachloroethylene	6	7
86. toluene	105	134
89. aldrin	15	19
90. dieldrin	4	6
93. 4,4'-DDE(p,p'DDX)	0.13	0.17
100. heptachlor	11	13
102. α-BHC	29	36
103. β-BHC	3	3
104. γ-BHC	3	3
105. δ-BHC	13	16

Table C-1 (Continued)

TOTAL CATEGORY POLLUTANT MASS DISTRIBUTED BY DISCHARGE MODE

CONTACT COOLING AND HEATING WATER SUBCATEGORY (Continued)

Priority Polultants	Direct Dischargers Pollutant Mass (kg/yr)	Indirect Dischargers Pollutant Mass (kg/yr)
118. cadmium	167	213
119. chromium (Total)	440	560
120. copper	223	284
122. lead	2,360	3,000
123. mercury	0.04	0.06
124. nickel	426	543
128. zinc	3,510	4,460
TOTAL	123,845.17	157,657.23

Table C-1 (Continued)

TOTAL CATEGORY POLLUTANT MASS DISTRIBUTED BY DISCHARGE MODE

CLEANING AND FINIHSING WATER SUBCATEGORY

Conventional Pollutants	Direct Dischargers Pollutant Mass (kg/yr)	Indirect Dischargers Pollutant Mass (kg/yr)
BOD_5	299,000	634,000
Oil and Grease	34,600	73,400
TSS	378,000	802,000
TOTAL	711,600	1,509,400
Nonconventional Pollutants		
COD	480,000	1,020,000
TOC	416,000	884,000
Total Phenols	43,200	91,800
TOTAL	939,200	1,995,800
Priority Pollutants		
4. benzene	0.6	1.4
23. chloroform (trichloromethane)	22	48
44. methylene chloride (dichloromethane)	303	645
62. N-nitrosodiphenylamine	15	31
65. phenol	73	154
66. bis(2-ethylhexyl) phthalate	12	27
86. toluene	2	4
89. aldrin	0.2	0.4
100. heptachlor	0.03	0.07
102. α-BHC	0.002	0.004
104. γ-BHC	0.2	0.5
105. δ-BHC	0.3	0.6
119. chromium (Total)	40	84
120. copper	64	137
124. nickel	30	65
125. selenium	1	2
128. zinc	327	696
TOTAL	890.332	1,895.974

Because Option 2 for the contact cooling and heating water subcategory is a combination of zero discharge and activated sludge treatment, a portion of the benefits for this option was attributed to zero discharge and the remaining portions were obtained by the treatment technology. These portions were based on the percentage of plastic products produced and not the volume of wastewater discharged since the pollutant masses are dependent on the amount of plastic produced. For the contact cooling and heating water subcategory, 43 percent of the total plastic is formed by processes with a process water usage flow rate of 35 gpm or less. This percentage is for direct dischargers and was obtained from the questionnaire data base. Thus, 43 percent of the total pollutant mass is removed by the processes with a process water usage flow rate of 35 gpm or less (i.e., zero discharge of pollutants). The remaining 57 percent of the pollutant mass was multiplied by the removal efficiencies for the activated sludge process presented in Table C-2 to determine the additional benefit derived from treating wastewaters discharged by processes with an average process water usage flow rate greater than 35 gpm.

Also listed in Table C-2 are the sources of the percent removals. The percent removals for conventional pollutants were determined by using the effluent concentration values transferred from the organic chemicals, plastics and synthetic fibers category (see Section X). There is zero percent removal of TSS, because the PM&F wastewater TSS concentration (17 mg/l) is below the TSS effluent concentration value (36 mg/l). Percent removals for the nonconventional pollutants were obtained from the source listed in Table C-2. Priority toxic pollutant removals for the package activated sludge plant were calculated in the following way:

1. Pollutant treatability limits were obtained from USEPA, Contractors Engineering Report, Analysis of Organic Chemicals and Plastics/Synthetic Fiber Industries, Toxic Pollutants, November 16, 1981, Contract No. 68-01-6024. If a treatability limit was below the analytical detection limit, the treatability limit was made equal to the detection limit for a pollutant. A percent removal was calculated using the influent concentration to the package activated sludge plant and the treatability limit. If a limit was not listed for a pollutant, the next source was searched.

2. Percent removals of pollutants were obtained from the USEPA, Fate of Priority Pollutants in Publicly Owned Treatment Works, Volume I, September 1982, 440/1-83/303.

Table C-2

OPTION 2 POLLUTANT PERCENT REMOVALS CONTACT COOLING AND HEATING WATER SUBCATEGORY

Conventional Pollutants	% Removal	Source
BOD_5	78	Percent removals were calculated using effluent concentration data transferred from the organic chemicals, plastics, and synthetic fibers category
Oil and Grease	19	
TSS	0	
Nonconventional Pollutants		
COD	63	5
TOC	63	5
Total Phenols	60	5
Priority Pollutants		
4. benzene	66	1
6. carbon tetrachloride (tetrachloromethane)	73	2
11. 1,1,1-trichloroethane	73	1
22. parachlorometa cresol	40	1
23. chloroform (trichloromethane)	90	1
44. methylene chloride (dichloromethane)	88	1
65. phenol	92	1
66. bis(2-ethylhexyl) phthalate	40	3
68. di-n-butyl phthalate	17	1
85. tetrachloroethylene	67	1
86. toluene	38	1
89. aldrin	20	2
90. dieldrin	0	4
93. 4,4'-DDE	0	4
100. heptachlor	85	2
102. α-BHC	77	2
103. β-BHC	0	4
104. γ-BHC	44	2
105. δ-BHC	52	2
118. cadmium	83	1

Table C-2 (Continued)

OPTION 2 POLLUTANT PERCENT REMOVALS CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutants	% Removal	Source
119. chromium (Total)	76	2
120. copper	82	2
122. lead	83	1
123. mercury	75	1
124. nickel	35	2
128. zinc	77	2

1. Percent removal is based on the analytical detection limit.

2. Percent removal is from the USEPA, Fate of Priority Pollutants in Publicly Owned Treatment Works, Volume I, September 1982, 440/1-82-303.

3. Percent removal is determined from the USEPA, Contractors Engineering Report, Analysis of Organic Chemicals and Plastics/Synthetic Fibers Industries Toxic Pollutants, November 16, 1981, Contract No. 68-01-0624.

4. Removal efficiencies not presented in sources.

5. Percent removals are from USEPA, Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, July 1980, EPA 600/8-80-842c.

3. If the percent removal from the POTW study resulted in an effluent concentration below the pollutant analytical quantification level, the effluent concentration was made equal to the analytical quantification level, and the percent removal was adjusted using that concentration.

Table C-3 presents the pollutant mass removals for Option 2 and the pollutant masses remaining after treatment. The calculation procedure for BOD_5 removal is described below:

1. The total direct discharge mass for BOD_5 is 7,920,000 kg/yr (from Table C-1).
2. Forty-three percent of the BOD_5 pollutant mass was eliminated because of zero discharge of pollutants. This benefit is 3,410,000 kg/yr (3,410,000 = 0.43 x 7,920,000).
3. The remaining pollutant mass available for treatment in a package activated sludge plant is 4,510,000 kg/yr (4,510,000 = 7,920,000 - 3,410,000).
4. The pollutant percent removal in the package activated sludge plant is 78 percent. Pollutant mass removals in the package activated plant are 3,520,000 kg/yr (3,520,000 = 0.78 x 4,510,000).
5. Total pollutant benefits are the portion of pollutants removed by zero discharge and the portion removed by the package activated sludge plant. These benefits equal 6,930,000 kg/yr (6,930,000 = 3,410,000 + 3,520,000).
6. The BOD_5 pollutant mass remaining after treatment is 990,000 kg/yr (7,920,000 - 6,930,000 = 990,000).

Other pollutant benefits were calculated using this procedure.

Table C-4 lists the Option 2 influent and effluent concentrations for the contact cooling and heating water pollutants. The percent removals listed in Table C-2 were applied to the influent concentrations (see Table VII-5) to calculate the treatment system effluent concentrations.

Option 3

The technology for Option 3 for contact cooling and heating water is:

For processes with an average process water usage flow rate of 35 gpm or less the technology is zero discharge by 100 percent recycle of the wastewater through either a tank or a chiller.

Table C-3

POLLUTANT BENEFITS AND AMOUNTS REMAINING AFTER BPT OPTION 2

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Conventional Pollutants	Option 2 Benefits (kg/yr)	Pollutant Mass Remaining After Treatment (kg/yr)
BOD_5	6,930,000	990,000
Oil and Grease	380,800	327,200
TSS	127,000	168,000
TOTAL	7,437,800	1,485,200
Nonconventional Pollutants		
COD	15,310,000	4,090,000
TOC	6,000,000	1,610,000
Total Phenols	179,800	53,200
TOTAL	21,489,800	5,753,200
Priority Pollutants		
4. benzene	3,540	850
6. carbon tetrachloride (tetrachloromethane)	51,000	9,300
11. 1,1,1-trichloroethane	5,250	950
22. parachlorometa cresol	1,329	691
23. chloroform (trichloromethane)	4,560	280
44. methylene chloride (dichloromethane)	5,290	390
65. phenol	1,537	73
66. bis(2-ethylhexyl) phthalate	19,880	10,320
68. di-n-butyl phthalate	680	610
85. tetrachloroethylene	4.9	1.1
86. toluene	68	37
89. aldrin	8.2	6.8
90. dieldrin	1.7	2.3
93. 4,4'-DDE(p,p'DDX)	0.06	0.07
100. heptachlor	10.1	0.9
102. α-BHC	25	4
103. β-BHC	1.3	1.7

Table C-3 (Continued)

POLLUTANT BENEFITS AND AMOUNTS REMAINING AFTER BPT OPTION 2

CONTACT COOLING AND HEATING WATER SUBCATEGORY

Priority Pollutants	Option 2 Benefits (kg/yr)	Pollutant Mass Remaining After Treatment (kg/yr)
104. γ-BHC	2.05	0.95
105. δ-BHC	9.4	3.6
118. cadmium	151	16
119. chromium (Total)	380	60
120. copper	200	23
122. lead	2,130	230
123. mercury	0.035	0.005
124. nickel	268	158
128. zinc	3,050	460
TOTAL	99,375.745	24,469.425

Table C-4

INFLUENT AND EFFLUENT POLLUTANT CONCENTRATIONS - OPTION 2
CONTACT COOLING AND HEATING WATER SUBCATEGORY

Conventional Pollutants	Influent Concentration (mg/l)	Effluent Concentration (mg/l)
BOD$_5$	102	22
Oil and Grease	21	17
TSS	17	17
Nonconventional Pollutants		
COD	241	89
TOC	74	27
Total Phenols	149	60
Priority Pollutants		
4. benzene	0.029	0.010
6. carbon tetrachloride (tetrachloromethane)	1.176	0.318
11. 1,1,1-trichloroethane	0.037	0.010
22. parachlorometa cresol	0.042	0.025
23. chloroform (trichloromethane)	0.097	0.010
44. methylene chloride (dichloromethane)	0.086	0.010
65. phenol	0.316	0.025
66. bis(2-ethylhexyl) phthalate	0.333	0.200
68. di-n-butyl phthalate	0.012	0.010
85. tetrachloroethylene	0.030	0.010
86. toluene	0.016	0.010
89. aldrin	315†	252†
90. dieldrin	41†	41†
93. 4,4'-DDE(p,p'DDX)	44†	44†
100. heptachlor	203†	30†
102. α-BHC	250†	56†
103. β-BHC	176†	176†
104. γ-BHC	132†	74†
105. δ-BHC	104†	50†
118. cadmium	0.023	0.004
119. chromium (Total)	0.050	0.012
120. copper	0.228	0.041
122. lead	0.248	0.042
123. mercury	0.0004	0.0001
124. nickel	0.686	0.446
128. zinc	0.190	0.044

†Concentration is in nanograms per liter.

For processes with an average process water usage flow rate greater than 35 gpm the technology is recycle through a cooling tower and zero discharge by contract haul of the discharge from the recycle tank.

This option results in zero discharge of pollutants from all processes using process water for contact cooling and heating. Benefits for this option are equal to the total pollutant masses for direct dischargers listed in Table C-1.

CLEANING AND FINISHING WATER SUBCATEGORY

Option 1

The technology for Option 1 consists of a tank in which the velocity of the wastewater is reduced so that solid material can settle by gravitational force. Acidic or basic material is added to either the tank influent or the tank effluent to adjust the pH of the wastewater.

Pollutant removals for this option were calculated using percent removals from the USEPA Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, July 1980, EPA-600-8-80-042c, for sedimentation. Percent removals were applied to conventional, nonconventional and priority toxic metal pollutants. The percent removal for selenium was adjusted to 57 percent from the treatability manual percent removal of 63 percent, because the 63 percent removal reduced the effluent concentration below the analytical detection limit for that pollutant. The organic priority pollutants are not removed by sedimentation because they are dissolved. Table C-5 lists the percent removals. These percent removals were applied to the total pollutant masses for direct dischargers listed in Table C-1 for the cleaning and finishing water subcategory to calculate the benefits. The benefits and pollutant masses remaining after treatment for Option 1 are presented in Table C-6. Concentrations before and after Option 1 treatment are listed in Table C-7. The percent removals in Table C-5 were applied to the raw wastewater average concentration to calculate the effluent concentrations after treatment.

Option 2

This option consists of recycle through a sedimentation tank and treatment of the discharge from the recycle unit in a package activated sludge plant. The package plant includes an equalization unit and pH adjustment.

The benefits for Option 2 include pollutant mass removals in the sedimentation tank and in the activated sludge plant. Because processes with a process water usage flow rate of two gpm or less

Table C-5

OPTION 1 POLLUTANT PERCENT REMOVALS
CLEANING AND FINISHING WATER SUBCATEGORY

	%* Removal
Conventional Pollutants	
BOD_5	33
Oil and Grease	47
TSS	82
Nonconventional Pollutants	
COD	71
TOC	40
Total Phenols	43
Priority Pollutants	
4. benzene	0
23. chloroform (trichloromethane)	0
44. methylene chloride (dichloromethane)	0
62. N-nitrosodiphenylamine	0
65. phenol	0
66. bis(2-ethylhexyl) phthalate	0
86. toluene	0
89. aldrin	0
100. heptachlor	0
102. α-BHC	0
104. γ-BHC	0
105. δ-BHC	0
119. chromium (Total)	76
120. copper	66
124. nickel	61
125. selenium	57**
128. zinc	51

*Percent removals are from the USEPA, Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, July 1980, 600-8-80-042c.

**The percent removal for selenium is based on the analytical detection limit because the Treatability Manual percent removal reduces the effluent concentration below the analytical detection limit for that pollutant.

Table C-6

POLLUTANT BENEFITS AND AMOUNTS REMAINING AFTER BPT OPTION 1

CLEANING AND FINISHING WATER SUBCATEGORY

Conventional Pollutants	Option 1 Benefits (kg/yr)	Pollutant Mass Remaining After Treatment (kg/yr)
BOD_5	98,700	200,300
Oil and Grease	16,300	18,300
TSS	310,000	68,000
TOTAL	425,000	286,600
Nonconventional Pollutants		
COD	341,000	139,000
TOC	166,000	250,000
Total Phenols	18,600	24,600
TOTAL	525,600	413,600
Priority Pollutants		
4. benzene	0	0.6
23. chloroform (trichloromethane)	0	22
44. methylene chloride (dichloromethane)	0	303
62. N-nitrosodiphenylamine	0	15
65. phenol	0	73
66. bis(2-ethylhexyl) phthalate	0	12
86. toluene	0	2
89. aldrin	0	0.2
100. heptachlor	0	0.03
102. α-BHC	0	0.002
104. γ-BHC	0	0.2
105. δ-BHC	0	0.3
119. chromium (Total)	30	10
120. copper	42	22
124. nickel	18	12
125. selenium	0.57	0.43
128. zinc	167	160
TOTAL	257.57	632.762

Table C-7

INFLUENT AND EFFLUENT POLLUTANT CONCENTRATIONS - BPT OPTION 1

CLEANING AND FINISHING WATER SUBCATEGORY

Conventional Pollutants	Influent Concentration (mg/l)	Effluent Concentration (mg/l)
BOD_5	100	67
Oil and Grease	130	69
TSS	1,840	331
Nonconventional Pollutants		
COD	410	119
TOC	1,371	823
Total Phenols	134	76
Priority Pollutants		
4. benzene	0.026	0.026
23. chloroform (trichloromethane)	0.045	0.045
44. methylene chloride (dichloromethane)	0.067	0.067
62. N-nitrosodiphenylamine	0.036	0.036
65. phenol	1.334	1.334
66. bis(2-ethylhexyl) phthalate	0.059	0.059
86. toluene	0.120	0.120
89. aldrin	52†	52†
100. heptachlor	18†	18†
102. α-BHC	5†	5†
104. γ-BHC	535†	535†
105. δ-BHC	116†	116†
119. chromium (Total)	0.112	0.027
120. copper	0.401	0.136
124. nickel	0.136	0.053
125. selenium	0.175	0.075
128. zinc	3.375	1.654

†Concentration is in nanograms per liter.

were costed for zero discharge by contract haul, a portion of the benefits after sedimentation was attributed to zero discharge and the remaining portion was attributed to the treatment system. As in the contact cooling and heating water subcategory, these portions were determined using the percentage of plastics produced and not the volume of wastewater discharged, because the pollutant masses are dependent on the amount of plastics produced. For the cleaning and finishing water subcategory, 12.7 percent of the total plastic amount is processed by processes with an average process water usage flow rate of two gpm or less. This percentage for direct dischargers was obtained from the questionnaire data base.

The percent removals and benefits for BPT Option 1 apply to the sedimentation tank (i.e., the recycle unit) in Option 2 (see Tables C-5 and C-6). The percent removals for the package activated sludge plant in the cleaning and finishing subcategory were determined as described in BPT Option 2 for the contact cooling and heating water subcategory. The influent concentrations to the activated sludge process are the concentrations after sedimentation. Table C-8 lists the percent removals for the package activated sludge plant for the cleaning and finishing water subcategory.

The pollutant mass removals for BPT Option 2 and the pollutant masses remaining are presented in Table C-9. The procedure used to calculate for BOD_5 removal is described below:

1. The total direct discharger BOD_5 mass load is 299,000 kg/yr (from Table C-1).

2. The benefit for sedimentation is 33 percent BOD_5 removal or 98,700 kg/yr (98,700 = 0.33 x 299,000).

3. After sedimentation 200,300 kg/yr (200,300 = 299,000 - 98,700) remain.

4. Of this amount, 12.7 percent is removed from processes with an average process water usage flow rate of two gpm or less by zero discharge of pollutants. Benefits for zero dischargers are 25,400 kg/yr (25,400 = 0.127 x 200,300).

5. The remaining pollutant mass available for treatment in a package activated sludge plant is 174,900 kg/yr (174,900 = 200,300 - 25,400).

6. The BOD_5 percent removal in the package activated sludge plant is 67 percent. BOD_5 removal in that process is 117,000 kg/yr (117,000 = 0.67 x 174,900).

Table C-8

PACKAGE ACTIVATED SLUDGE PLANT PERCENT REMOVALS - BPT OPTION 2
CLEANING AND FINISHING WATER SUBCATEGORY

Conventional Pollutants	% Removal	Source
BOD_5	67	Percent removals were calculated using effluent concentration data transferred from the organic chemicals, plastics, and synthetic fibers category
Oil and Grease	75	
TSS	89	
Nonconventional Pollutants		
COD	63	5
TOC	63	5
Total Phenols	60	5
Priority Pollutants		
4. benzene	62	1
23. chloroform (trichloromethane)	78	1
44. methylene chloride (dichloromethane)	85	1
62. N-nitrosodiphenylamine	72	1
65. phenol	98	1
66. bis(2-ethylhexyl) phthalate	0	3
86. toluene	92	1
89. aldrin	20	2
100. heptachlor	85	2
102. α-BHC	60	1
104. γ-BHC	44	2
105. δ-BHC	55	2
119. chromium (Total)	74	1
120. copper	82	2
124. nickel	35	2
125. selenium	0	4
128. zinc	77	2

1. Percent removal is based on the analytical detection limit.
2. Percent removal is from the USEPA, Fate of Priority Pollutants in Publicly Owned Treatment Works, Volume I, September 1982, 440/1-82-303.
3. Percent removal is determined from the USEPA, Contractors Engineering Report, Analysis of Organic Chemicals and Plastics/Synthetic Fibers Industries Toxic Pollutants, November 16, 1981, Contract No. 68-01-6024.
4. The influent concentration is below the analytical detection limit after sedimentation.
5. Percent removals are from USEPA, Treatability Manual, Volume III, Technologies for Control/Removal of Pollutants, July 1980, EPA 600/8-80-842c.

Table C-9

POLLUTANT BENEFITS AND AMOUNTS REMAINING AFTER BPT OPTION 2

CLEANING AND FINISHING WATER SUBCATEGORY

	Option 2 Benefits (kg/yr)	Pollutant Mass Remaining After Treatment (kg/yr)
Conventional Pollutants		
BOD_5	241,100	57,900
Oil and Grease	30,620	3,980
TSS	371,440	6,560
TOTAL	643,160	68,440
Nonconventional Pollutants		
COD	435,100	44,900
TOC	334,800	81,200
Total Phenols	34,620	8,580
TOTAL	804,520	134,680
Priority Pollutants		
4. benzene	0.401	0.199
23. chloroform (trichloromethane)	18	4
44. methylene chloride (dichloromethane)	263	40
62. N-nitrosodiphenylamine	11	4
65. phenol	72	1
66. bis(2-ethylhexyl) phthalate	2	10
86. toluene	1.86	0.14
89. aldrin	0.06	0.14
100. heptachlor	0.026	0.004
102. α-BHC	0.0013	0.0007
104. γ-BHC	0.102	0.098
105. δ-BHC	0.182	0.118
119. chromium (Total)	37.7	2.3
120. copper	61	3
124. nickel	23.5	6.5
125. selenium	0.62	0.38
128. zinc	295	32
TOTAL	786.4523	103.8797

7. Total benefits are the removals in the sedimentation tank, the portion of pollutants removed by zero dischargers and the portion of pollutants removed in the package activated sludge plant. These removals are 241,100 kg/yr (241,100 = 98,700 + 25,400 + 117,000).

8. The BOD_5 pollutant mass remaining after treatment is 57,900 kg/yr (57,900 = 299,000 - 241,100).

Other pollutant removals were calculated using the above procedure.

Table C-10 lists the pollutant concentrations before Option 2 treatment, after the sedimentation process, and after the package activated sludge plant for Option 2. The percent removals listed in Tables C-5 and C-8 were used to calculate the effluent concentrations from the sedimentation tank and the package activated sludge plant, respectively.

Option 3

Option 3 consists of recycle through a sedimentation tank for all processes and contract haul of the discharge from the recycle unit. This option results in zero discharge of pollutants from all processes that use process water for cleaning and finishing. Benefits for this option are equal to the total pollutant mass for direct dischargers listed in Table C-1.

BENEFITS SUMMARY

Table C-11 lists the total pollutant masses for conventional, nonconventional, and priority pollutants for direct dischargers, benefits, and the pollutant masses remaining after treatment for each option by subcategory.

Table C-10

POLLUTANT CONCENTRATIONS - BPT OPTION 2
CLEANING AND FINISHING WATER SUBCATEGORY

		Option 2	
Conventional Pollutants	Influent Concentration (mg/l)	Concentration After Sedimentation (mg/l)	Concentration After Activated Sludge Treatment (mg/l)
BOD_5	100	67	22
Oil and Grease	130	69	17
TSS	1,840	331	36
Nonconventional Pollutants			
COD	410	119	44
TOC	1,371	823	304
Total Phenols	134	76	30
Priority Pollutants			
4. benzene	0.026	0.026	0.010
23. chloroform (trichloromethane)	0.045	0.045	0.010
44. methylene chloride (dichloromethane)	0.067	0.067	0.010
62. N-nitrosodiphenylamine	0.036	0.036	0.010
65. phenol	1.334	1.334	0.025
66. bis(2-ethylhexyl) phthalate	0.059	0.059	0.059
86. toluene	0.120	0.120	0.010
89. aldrin	52†	52†	41.6†
100. heptachlor	18†	18†	2.7†
102. α-BHC	5†	5†	2†
104. γ-BHC	535†	535†	300†
105. δ-BHC	116†	116†	52.2†
119. chromium (Total)	0.112	0.027	0.007
120. copper	0.401	0.136	0.024
124. nickel	0.136	0.053	0.034
125. selenium	0.175	0.075	0.075
128. zinc	3.375	1.654	0.380

†Concentration is in nanograms per liter.

Table C-11

POLLUTANT MASS SUMMARY

		Raw Waste Pollutant Masses for Direct Dischargers (kg/yr)	Pollutant Benefits (kg/yr)	Pollutant Masses Remaining After Treatment (kg/yr)
Contact Cooling and Heating Water Subcategory				
Option 1	Conventional Pollutants	8,923,000	0	8,923,000
	Nonconventional Pollutants	27,243,000	0	27,243,000
	Priority Pollutants	123,845	0	123,000
Option 2	Conventional Pollutants	8,923,000	7,437,800	1,485,200
	Nonconventional Pollutants	27,243,000	21,489,800	5,753,200
	Priority Pollutants	123,845	99,376	24,469
Option 3	Conventional Pollutants	8,923,000	8,923,000	0
	Nonconventional Pollutants	27,243,000	27,243,000	0
	Priority Pollutants	123,845	123,845	0
Cleaning and Finishing Water Subcategory				
Option 1	Conventional Pollutants	711,600	425,000	286,600
	Nonconventional Pollutants	939,200	525,600	413,600
	Priority Pollutants	890	258	632
Option 2	Conventional Pollutants	711,600	643,160	68,440
	Nonconventional Pollutants	939,200	804,520	134,680
	Priority Pollutants	890	786	104
Option 3	Conventional Pollutants	711,600	711,600	0
	Nonconventional Pollutants	939,200	939,200	0
	Priority Pollutants	890	890	0

APPENDIX D

TRANSFER OF TREATMENT TECHNOLOGY PERFORMANCE DATA AND CALCULATION OF PRODUCTION NORMALIZED FLOWS - PM&F CATEGORY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 16 1984

MEMORANDUM

SUBJECT: Transfer of Treatment Technology Performance Data and Calculation of Production Normalized Flows - PM&F Category

FROM: R. Clifton Bailey, Statistician
Program Integration and Evaluation Staff (WH-586) RCB

TO: Robert M. Southworth, Project Officer
Effluent Guidelines Division (WH-552)

Purpose

This memorandum discusses the transfer of performance data for the activated sludge process for biochemical oxygen demand (BOD_5), total suspended solids (TSS), and oil and grease (O&G) from the organic chemicals, plastics, and synthetic fibers (OCPSF) category to the plastics molding and forming (PM&F) category. It also discusses the production normalized flows (PNF) used to calculate the proposed effluent limitations guidelines and standards for the PM&F category.

Background

Effluent limitations guidelines and standards for processes in the PM&F category that discharge wastewater to navigable waters (i.e., direct dischargers) are currently being developed. For regulatory purposes, the PM&F category has been divided into two subcategories:

- contact cooling and heating water subcategory, and
- cleaning and finishing water subcategory.

The technology basis for the best practicable technology currently available (BPT) effluent limitations guidelines and standards for both subcategories is flow reduction and treatment of the discharge from the flow reduction unit in an activated sludge plant. However no effluent data on activated sludge treatment of PM&F only wastewater were available.* To obtain effluent concentration data, we first compared the PM&F untreated wastewater data for BOD_5, TSS and, O&G to data for those pollutants at plastic manufacturing plants (PMP) in the OCPSF category. Results of that comparison are presented in this memorandum. Because the wastewaters from PM&F and PMP plants have similar BOD_5, TSS, and O&G characteristics, it is appropriate to use activated sludge effluent data for those pollutants from the OCPSF category to determine limitations for the PM&F category. Those data are also presented in this memorandum.

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* There are no plants in the Agency's data base that treat PM&F wastewter only in an activated sludge system. Several integrated facilities are known to combine PM&F wastewater with other industrial wastewater for treatment by activated sludge. EPA does not have effluent data from these systems.

To determine the amount of pollutants that can be discharged, effluent concentration data for the activated sludge process were multipled by a product normalized flow (liters discharged per mass of plastic material processed). The amount of plastic material processed was selected as the normalizing parameter for the PM&F category because the amount of water used and the amount of pollutants discharged are related to the amount of plastic material processed. The PNFs for each PM&F subcategory were calculated by adding the amount of wastewater discharged by plants in the PM&F data base that currently recycle process water. The total amount of wastewater discharged was divided by the total production reported for those plants to obtain the PNFs. Data used to calculate the PNFs for each subcategory are presented in this memorandum.

Data

Plastics Molding and Forming Process Data:

Samples of untreated process water were collected at 11 plastics molding and forming (PM&F) plants. The biological oxygen demand (BOD_5), total suspended solids (TSS), and oil and grease (O&G) concentrations found in these samples are listed in Appendix IIIA. Concentration data for these pollutants are presented for both contact cooling and heating water and cleaning and finishing water.

Plastics Manufacturing Data:

The technical development document (Development Document for Effluent Limitations Guidelines and Standards for the Organic Chemicals and Plastics, and Synthetic Fibers Point Source Category, Volume 1 (Proposed BPT), EGD, EPA 440/1-83/0096 - hereafter referred to as the "Organics BPT Development Document") contains a summary of BOD_5 and TSS data used to establish proposed effluent limitations guidelines for the plastics only subcategory of the OCPSF category. The effluent limitations guidelines for that subcategory are based on data from well-operated activated sludge processes at six plastics manufacturing plants (Nos. 9, 44, 45, 96, 111, 126). These well-operated treatment processes were identified through an engineering analysis of the performance data for those processes (see page 190 of the Organics BPT Development Document for a summary). BOD_5 and TSS data were available from effluent samples at five of these six plants (Nos. 9, 44, 45, 111, 126). These data are presented in Appendix IIIB.

Oil and grease (O&G) data were not available for the six well-operated wastewater treatment systems at the plastics manufacturing plants in the plastics only subcategory. Limitations for O&G were developed on the basis of data from 4 plants (3, 61, 124, 170) in the OCPSF data base that manufactured plastics (not necessarily plastics only plants) and use activated sludge treatment.

The limitations were developed on the basis of a lognormal distribution fit to the data. The goodness-of-fit of the lognormal model for the O&G effluent data was examined using a graphical procedure described in Appendix I. As stated in Appendix I, the plots presented in Appendix IIC support the lognormal distribution as a model for the O&G effluent data. The same graphical procedure was used to demonstrate lognormality for BOD_5 and TSS in the Organics BPT Development Document.

Plastics Molding and Forming Production and Flow Data:

In addition to the sampling data described above, the Agency conducted a questionnaire survey of the PM&F industry. Production and wastewater discharge data obtained in this survey for PM&F plants that currently recycle process water are listed in Appendix IIIC for the two PM&F subcategories. These data were used to calculate the production normalized flow for each PM&F category.

Process Wastewater Comparison

BOD_5, TSS, and O&G concentration values in untreated PM&F process wastewater were compared to the concentration values for those pollutants in untreated PMP process wastewater. Plant averages and log-variances were used for the comparisons. The log-variance is a direct measure of the variability in the data (see Appendix I). Together the plant averages and log-variances provide a statistical summary of the process wastewater concentrations. The plant averages and log-variances were computed for each of the PM&F subcategories and for the plastics manufacturers plants (see Appendix I for a summary of the computational procedures). The results, ordered from smallest to largest mean and log-variance, are presented in Tables 1 and 2.

A nonparametric test, the Mann-Whitney U/Wilcoxon T test for two independent samples, was used to make statistical comparisons. The comparisons (summarized in Table 3) were made separately for plant means and plant log-variances. In none of the test results was the median of the PM&F means and log-variances found to be significantly greater than the PMP values. Consequently, PM&F process wastewater is neither significantly greater in average concentration nor more variable than the PMP process wastewater for BOD_5, TSS or O&G. This statistical analysis supports the judgment that BOD_5, TSS, and O&G effluent concentrations for activated sludge treatment at PM&F process wastewater should neither be greater nor more variable than the effluent concentrations for those pollutants for an activated sludge process used to treat PMP process wastewater. We conclude, therefore, that the BOD_5, TSS and O&G concentration in PM&F process wastewater and PMP process wastewater are similar and that activated sludge treatment of PM&F wastewater can achieve the effluent concentration values for BOD_5, TSS, and O&G for the OCPSF category.

Effluent Concentration Values

The BOD_5, TSS, and O&G effluent concentration values for the activated sludge processes that were transferred from the OCPSF category are presented in Table 4. These values were used to calculate the PM&F effluent limitations guidelines presented in Table 7. The BOD and TSS concentration limits are the same as the plastics only limitations shown on page 280, Table 4-1 of the Organics BPT Development Document. The Organics BPT Development Document does not contain oil and grease effluent concentration values for the plastics only subcategory. Consequently, the effluent data for four plants that manufacture plastics and organics (3, 61, 124, 170) (see the Data Section above of this memorandum) were used to compute the O&G effluent limitations shown in Table 4. The O&G concentration values shown in Table 4 are the products of the long-term median (median of the plant averages) and the average varibility factors based on the lognormal distribution (from Table 5). The variability factors for the four PMP plants are shown in Table 5. The computational procedures described in Appendix I follow closely the procedures in Appendix B of the Organics BPT Development Document.

Production Normalized Flow

The production normalized flow (PNF) for each subcategory (or portion of subcategory) was calculated by dividing the amount of wastewater discharged by PM&F processes that currently recycle process water by the total production for those processes. Table 6 contains those PNFs. Data used to calculate the PNFs are presented in Appendix IIIC.

The Agency calculated and applies only one PNF to all the contact cooling and heating water processes. The normalizing parameter used to calculate the PNF is the mass of plastic material cooled or heated. Because the amount of water needed to cool or heat a product is dependent on the mass of plastic material and not the type of process or product one PNF is appropriate for all cooling and heating processes. Two PNFs were calculated for the cleaning and finishing water subcategory, one for cleaning processes and one for finishing processes. Again, the normalizing parameter used is the mass of plastic material. Two PNFs are needed for this subcategory because the water usage requirements for cleaning operations were found to be substantially different than those for finishing operations.

BPT Effluent Limitations

Table 7 lists the proposed BPT mass-based effluent limitations guidelines for each subcategory. These limitations were calculated by multiplying the transferred effluent concentration values for BOD_5, TSS, and O&G by the PNFs.

TABLE 1

Summary of Process Wastewater Data for PM&F and Plastics Manufacturing Plants Cleaning and Finishing Water Subcategory

TABLE 1

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                     RANKED LISTING OF PMF & PMP DATA BY SUBCATEGORY
---- -------- ------------------------- SUBCAT=CLEANING & FINISHING   POLNAME=BOD -------------------------------------------
                          TYPE     PLANT        MEAN    RANKMEAN

                          PMF       I           5.25        1
                          PMF       K          20.00        2
                          PMF       B          45.06        3
                          PMF       C          62.82        4
                          PMP       9          84.74        5
                          PMP       111        94.82        6
                          PMF       F         200.59        7
                          PMF       A         361.80        8
                          PMP       45        381.14        9
                          PMP       44        754.00       10
                          PMP       126      1087.47       11

----------------------------------------- SUBCAT=CLEANING & FINISHING   POLNAME=OAG -------------------------------------------
                          TYPE     PLANT        MEAN    RANKMEAN

                          PMF       A          4.000      2.5
                          PMF       B          4.000      2.5
                          PMF       D          4.000      2.5
                          PMF       K          4.000      2.5
                          PMF       C         11.250      5.0
                          PMP       61        17.393      6.0
                          PMP       124       22.902      7.0
                          PMP       3         41.139      8.0
                          PMF       I         48.467      9.0
                          PMP       170       79.277     10.0
                          PMF       F        133.047     11.0

----------------------------------------- SUBCAT=CLEANING & FINISHING   POLNAME=TSS -------------------------------------------
                          TYPE     PLANT        MEAN    RANKMEAN

                          PMF       B           4.00        1
                          PMF       K           6.00        2
                          PMF       C           6.20        3
                          PMF       D          10.50        4
                          PMP       9          27.25        5
                          PMF       A          33.60        6
                          PMP       111        42.84        7
                          PMF       F         234.80        8
                          PMP       45        304.32        9
                          PMP       126       557.00       10
                          PMP       44       3780.76       11
                          PMF       I        6752.14       12
```

TABLE 1 (Cont'd)

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                         RANKED LISTING OF PMF & PMP DATA BY SUBCATEGORY, POLLUTANT

----------------------------------------- SUBCAT=CLEANING AND FINISHING   POLNAME=BOD -----------------------------------------

                         TYPE    PLANT      N    VARIANCE    RANKVAR

                         PMF      K         1      .            .
                         PMF      C         3    0.08329        1
                         PMP      44       45    0.12644        2
                         PMF      I         8    0.12731        3
                         PMP      111     157    0.16975        4
                         PMP      45      148    0.17588        5
                         PMP      126     247    0.26334        6
                         PMP      9        23    0.67626        7
                         PMF      B         4    1.29565        8
                         PMF      F         6    1.46832        9
                         PMF      A         2    7.65196       10

----------------------------------------- SUBCAT=CLEANING AND FINISHING   POLNAME=OAG -----------------------------------------

                         TYPE    PLANT      N    VARIANCE    RANKVAR

                         PMF      K         1      .            .
                         PMF      A         2    0.00000        .
                         PMF      B         4    0.00000        .
                         PMF      D         2    0.00000        .
                         PMF      C         2    0.14776        1
                         PMP      61      234    0.39147        2
                         PMP      170     203    0.39781        3
                         PMP      3       157    0.61599        4
                         PMP      124      59    1.11618        5
                         PMF      I         8    1.69025        6
                         PMF      F         4    6.30013        7

----------------------------------------- SUBCAT=CLEANING AND FINISHING   POLNAME=TSS -----------------------------------------

                         TYPE    PLANT      N    VARIANCE    RANKVAR

                         PMF      K         1      .            .
                         PMF      B         4    0.00000        .
                         PMF      D         2    0.11786        1
                         PMP      111     148    0.17684        2
                         PMP      126     251    0.55877        3
                         PMP      9        24    0.56581        4
                         PMF      A         2    0.69461        5
                         PMF      C         3    0.82157        6
                         PMF      F         6    1.18541        7
                         PMP      45      257    1.47319        8
                         PMF      I         8    2.25857        9
                         PMP      44      249    2.61015       10
```

TABLE 2

Summary of Process Wastewater Data for PM&F and Plastics Manufacturing Plants (PMP) Contact Cooling and Heating Water Subcategory

TABLE 2

```
                                        RANKED LISTING OF PMF & PMP DATA BY SUBCATEGORY

---------------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=BOD ------------------------------------------

                                          TYPE     PLANT        MEAN    RANKMEAN

                                          PMF       B           5.00        1
                                          PMF       K           5.00        2
                                          PMF       E           5.36        3
                                          PMF       F           7.04        4
                                          PMF       J           8.42        5
                                          PMP       9          84.74        6
                                          PMF       C          90.87        7
                                          PMP       111        94.82        8
                                          PMF       G         137.33        9
                                          PMP       45        381.14       10
                                          PMP       44        754.00       11
                                          PMF       H         777.50       12
                                          PMP       126      1067.47       13

---------------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=OAG ------------------------------------------

                                          TYPE     PLANT        MEAN    RANKMEAN

                                          PMF       F         2.9293      1.0
                                          PMF       D         4.0000      3.5
                                          PMF       G         4.0000      3.5
                                          PMF       H         4.0000      3.5
                                          PMF       K         4.0000      3.5
                                          PMF       B         4.1084      6.0
                                          PMF       J        14.4884      7.0
                                          PMP       61       17.3932      8.0
                                          PMF       F        20.1298      9.0
                                          PMP       124      22.9017     10.0
                                          PMP       3        41.1395     11.0
                                          PMF       C        47.0000     12.0
                                          PMP       170      79.2773     13.0

---------------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=TSS ------------------------------------------

                                          TYPE     PLANT        MEAN    RANKMEAN

                                          PMF       F           2.54        1
                                          PMF       E           3.12        2
                                          PMF       B           4.00        3
                                          PMF       D           4.00        4
                                          PMF       K           4.02        5
                                          PMF       J           6.30        6
                                          PMF       H           7.25        7
                                          PMF       G          16.00        8
                                          PMP       9          27.25        9
                                          PMP       111        42.84       10
                                          PMF       C          66.33       11
                                          PMP       45        304.32       12
                                          PMP       126       557.00       13
                                          PMP       44       3780.76       14
```

TABLE 2 (Cont'd)

```
                                   RANKED LISTING OF PMF & PMP DATA BY SUBCATEGORY, POLLUTANT

----------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=BOD -----------------------------------

                                        TYPE    PLANT      N    VARIANCE    RANKVAR

                                        PMF      B         2    0.00000        .
                                        PMF      K         9    0.00000        .
                                        PMF      C         3    0.00445        1
                                        PMF      H         2    0.07376        2
                                        PMP      44       45    0.12644        3
                                        PMF      F         8    0.15944        4
                                        PMP      111     157    0.16975        5
                                        PMP      45      148    0.17588        6
                                        PMP      126     247    0.26334        7
                                        PMP      9        23    0.67626        8
                                        PMF      E        12    0.70006        9
                                        PMF      G         2    1.71324       10
                                        PMF      J         2    2.83112       11

----------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=OAG -----------------------------------

                                        TYPE    PLANT      N    VARIANCE    RANKVAR

                                        PMF      D         1     .             .
                                        PMF      G         2    0.00000        .
                                        PMF      H         3    0.00000        .
                                        PMF      K         9    0.00000        .
                                        PMF      E        12    0.06868        1
                                        PMF      B         2    0.15658        2
                                        PMF      C         3    0.30273        3
                                        PMF      F         6    0.37059        4
                                        PMP      61      234    0.39147        5
                                        PMP      170     203    0.39781        6
                                        PMP      3       157    0.61599        7
                                        PMP      124      59    1.11618        8
                                        PMF      J         2    1.46715        9

----------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=TSS -----------------------------------

                                        TYPE    PLANT      N    VARIANCE    RANKVAR

                                        PMF      D         1     .             .
                                        PMF      B         2    0.00000        .
                                        PMF      K         9    0.01827        1
                                        PMF      E        12    0.10972        2
                                        PMP      111     148    0.17684        3
                                        PMF      H         2    0.46569        4
                                        PMP      126     251    0.55877        5
                                        PMP      9        24    0.56581        6
                                        PMF      F         8    0.58818        7
                                        PMF      C         3    0.87990        8
                                        PMF      G         2    1.45308        9
                                        PMP      45      257    1.47319       10
                                        PMF      J         2    2.47447       11
                                        PMP      44      249    2.61015       12
```

TABLE 3

RESULTS OF THE COMPARISON OF PM&F AND PMP PROCESS WASTEWATER

Using Wilcoxon - T Test for 2 Independent Samples

One-Tailed Test H_O: PMF $\leq$ PMP

H_A: PMF > PMP

SUBCATEGORY	POLLUTANT	NUMBER OF PLANTS		RANK MEAN		T_x[1]	p[2]
		PMF	PMP	PMF	PMP		
PLANT MEANS RANKED							
Cleaning and Finishing Water	BOD_5	6	5	4.17	8.2	41	.974 NS
	O&G	7	4	5.00	7.75	31	.885 NS
	TSS	7	5	5.14	8.4	42	.926 NS
Contact Cooling and Heating Water	BOD_5	8	5	5.38	9.6	48	.967 NS
	O&G	9	4	5.44	10.0	42	.983 NS
	TSS	9	5	5.22	11.6	58	.998 NS
PLANT VARIANCES RANKED							
Cleaning and Finishing Water	BOD_5	5	5	6.2	4.8	31	.274 NS
	O&G	3	4	4.7	3.5	14	.314 NS
	TSS	5	5	5.6	5.4	28	.500 NS
Contact Cooling and Heating Water	BOD_5	6	5	6.17	5.8	29	.465 NS
	O&G	5	4	3.80	6.5	26	.915 NS
	TSS	7	5	6.00	7.2	36	.691 NS

Conclusion: In all cases, there was no significant difference between rank means.

[1] As defined by Gibbons, J.D., "Nonparametric Methods for Quantitative Analysis," Holt, Rinehard and Winston, 1976, p. 163.

[2] NS - not significant.

TABLE 4

BOD$_5$, O&G and TSS Effluent Concentration Values for Plastics Molders and Formers

(Concentration Values Are the Same for the Two Subcategories:

Pollutant	Long-Term Median	Maximum 30-Day (mg/l)	Maximum Daily (mg/l)
BOD5*	14.5	22	49
O&G	11.9	17	71
TSS*	24	36	117

* See Table 9-1, page 280, BPT Development Document.

TABLE 5

Variability Factors for O&G

Plant	N	Effluent Mean	Variability Factor 1-Day	Variability Factor 30-Day
3	46	13.0	6.44	*
61	348	14.6	3.77	1.37
124	100	5.2	9.27	*
170	163	10.8	4.21	*
		AVERAGE	5.92	1.37

* Not estimated. Fewer than five consecutive day-pairs available to estimate the 1-day lag correlation for the variability factor (see Appendix I).

TABLE 6

Production Normalized Flow

Subcategory	Discharge Flow (Liters/Year)	Production (KKG/Year)	Production Normalized Flow (Flow/Production) (Liters/KKG)
Cleaning & Finisning Water			
a) Cleaning	6115919	1364.5	4482
b) Finishing	983333	921.4	1067
Contact Cooling and Heating Water	13583148	8548.3	1589

TABLE 7

Effluent Limitations Guidelines by PM&F Subcategory

Cleaning and Finishing Water Subcategory	30-Day (mg/kg)	1-Day (mg/kg)
a) Cleaning Water		
BOD5	99	220
O&G	76	318
TSS	161	524
b) Finishing Water		
BOD5	23	52
O&G	18	76
TSS	38	125
Contact Cooling and Heating Water Subcategory		
BOD5	35	78
O&G	27	113
TSS	57	186

APPENDICES

I. Statistical Procedures

II. Summary Statistics

- A. PM&F Sampling Data
- B. PMP Data
- C. Probit Plots for PMP Oil and Grease Data

III. Data

- A. PM&F Process Sampling Program Data: BOD, O&G, and TSS
- B. PMP Data: Influent and Effluent BOD, O&G, and TSS
- C. PM&F Questionnaire Survey Data for Production and Discharge Flow

I. STATISTICAL PROCEDURES

Descriptive Statistics

Some of the more commonly employed descriptive statistics are defined as follows:

(1) N - number of valid observations used in a particular analysis (e.g., the total number of effluent samples at a particular plant for a particular pollutant)

(2) Mean - arithmetic average: $\overline{X} = \sum_{i=1}^{N} X_i/N$

(3) Variance - standard unbiased estimate: $S^2 = \frac{1}{N-1} \sum_{i=1}^{N} (X_i - \overline{X})^2$

Log-variance - variance with $X_i = \log_e$ (observation)

Daily variability factors depend directly on the log-variance (see the section of this Appendix below on Variability Factors).

(The standard deviation is $S = \sqrt{S^2}$.)

(4) Minimum - the smallest value in a set of N observations

(5) Maximum - the largest value in a set of N observations

(6) Range - the minimum subtracted from the maximum

(7) Median - the middle value in a set of N observations. If N is odd (N = 2k - 1 for some integer k), the median is the kth order statistic, C(k). If N is even (N = 2k), the median is

$$[C(k) + C(k + 1)]/2$$

(8) Stream Average - flow weighted average of sample concentrations

$$\overline{X} = \sum W_i X_i$$

where

$$W_i = f_i / \sum f_i$$

for sample concentration X_i and stream flow f_i

(9) Plant average - flow weighted average of stream concentrations

$$\overline{X} = \sum W_i X_i$$

where

$$W_i = f_i / \sum f_i$$

for sample average concentration x_i and stream average f_i. When flows are missing the plant average is the plant mean.

Goodness-of-Fit Test

The goodness-of-fit of the lognormal model for the O&G effluent data (PMP) was checked through a graphical procedure called a probability plot. Let X_1, ..., X_n denote the n observed daily values of the parameter of interest (the BOD or measurements from a given plant). Denote the rth largest of the n values by $X_{(r)}$, and define a corresponding score called the "probit" by

$$\text{Probit } [X_{(r)}] = \Phi^{-1}[r/(n + 1)],$$

where $\Phi^{-1}(\cdot)$ is the inverse of the standard normal cumulative distribution function. The probit score is the normal deviation (z-value) equivalent to the value $X_{(r)}$. Probit scores are useful because plots of X values versus corresponding probit scores tend to be straight lines when X is normally distributed; this fact is the basis for probability plots. If X has a lognormal distribution, a log-scale plot of X values versus probit scores tends to be a straight line. Daniel and Wood (1971) give simulated examples of probability plots to indicate the degree of random departure from a straight line to expect for different sample sizes when X is normally distributed. Probability plots for BOD and TSS are presented in Figures B-1 to B-28 of the BPT Development Document. Similar plots for O&G are presented in Appendix II C.

Based on the probability plots, it was concluded that the lognormal distribution was a reasonable model for the PMP oil and grease effluent data.

Variability Factors

Assuming that the distribution of the concentration c is lognormal, then $y = \log(c)$ is normally distributed with mean μ and variance σ^2 (Aitchison and Brown, pages 8-9). Thus the 99th percentile on the natural log scale is

$$y_{0.99} = \mu + 2.326\ \sigma\ ,$$

and the 99th percentile on the concentration scale is

$$c_{0.99} = \exp(y_{0.99}) = e^{\mu + 2.326\ \sigma}\ . \qquad (1)$$

The mean and variance on the concentration scale are:

$$\mu_c = e^{\mu + 1/2\ \sigma^2}$$

and

$$\sigma_c^2 = e^{2\mu + \sigma^2}\ (e^{\sigma^2} - 1).$$

Hence, the daily maximum variability factor under the lognormal model is

$$VF(1) = \frac{c_{0.99}}{\mu_c} = e^{2.326\,\sigma\,-\,1/2\,\sigma^2}\ . \tag{2}$$

Estimates of any of the above quantities are calculated by substituting the mean and variance of natural logs of the observations for μ and σ^2, respectively. Consequently, the daily maximum variability factor depends directly on the log-variance of the concentration.

Variability factors for 30-day average concentrations, VF(30), are based on the distribution of an average of values drawn from the distribution of daily values and take day-to-day correlation into account. Positive autocorrelation between concentrations measured on consecutive days means that such concentrations tend to be similar. An average of positively correlated concentration measurements is more variable than an average of independent concentrations. The following formulas incorporate the autocorrelation between concentration values measured on adjacent days.

The correlation (ρ) between adjacent days' measurements (i.e., the lag-1 autocorrelation) was estimated using the available data. Then using the first-order autoregressive model commonly found to be appropriate in water pollution modeling, the mean and variance of an average of n daily values, denoted by $\bar{c}$, were approximated by:

$$\mu_{\bar{c}} = \exp(\,\mu + \sigma^2/2) \tag{3}$$

and

$$\sigma^2_{\bar{c}} = \frac{\sigma^2_c}{n}\ \text{fn}\,(\rho), \tag{4}$$

with

$$\text{fn}(\,\rho\,) = 1 + (2/n)\sum_{k=1}^{n-1}(n-k)(\exp(\,\rho^k\,\sigma^2\,) - 1)/(\exp\sigma^2 - 1).$$

It can be seen in (4) that $\sigma^2_{\bar{c}}$ equals the variance of an average of n uncorrelated observations, $\sigma^2_c\,/n$, multiplied by a factor, fn$(\,\rho)$ that adjusts for the presence of autocorrelation. For oil and grease effluent data, the estimate for the lag-1 autocorrelation between logs of the concentration measurements was 0.5095 and the adjustment factor is 2.665. Similar adjustments were made in the Organics BPT Development Document for BOD_5 and TSS concentration values.

Finally, since $\bar{c}$ is approximately normally distributed by the Central Limit Theorem, the 95th percentile and variability factors of a 30-day average are approximately

$$\bar{c}_{0.95} = \mu_{\bar{c}} + 1.645\,\sigma_{\bar{c}} \tag{5}$$

and

$$\begin{aligned} VF(30) &= \bar{c}_{0.95}/\mu_{\bar{c}} \\ &= 1 + 1.645[e^{\sigma^2} - 1)f_{30}(\rho)30]^{1/2} \qquad (6) \end{aligned}$$

with $\mu_{\bar{c}}$ and $\sigma^2_{\bar{c}}$ defined by equations (3) and (4). Estimates of $\bar{c}_{0.95}$ or VF(30) are calculated by substituting estimates of μ, σ^2, and ρ into the formulas above.

References

Aitchison, J., and J.A.C. Brown (1957). The Lognormal Distribution, Cambridge University Press, London, 8-9.

Bradley, J.V. (1968). Distribution Free Statistical Tests, Prentice-Hall, Englewood Cliffs, NJ, 149-154, 326-330.

Daniel, C., and F.S. Wood (1971). Fitting Equations to Data, Wiley, New York, 34-43.

Kendall, M.G., and A. Stuart (1973). The Advanced Theory of Statistics, Vol. 2, 3rd Edition, Hafner, New York, 516-520.

APPENDIX II A

Summary Statistics for PM&F Sampling Data

```
            SUMMARY STATISTICS ON PMF DATA BY SUBCATEGORY, POLLTANT
                          RAW CONCENTRATION(MG/L)

---------------------------------------- SUBCAT=CLEANING & FINISHING   POLNAME=BOD ------------------------------------------

             PLANT     N   PLANT_AVG     MEDIAN      STD          MINIMUM     MAXIMUM

               A       2    361.800      229.50    311.834          9.0        450.0
               B       4     45.061       47.00     21.975          5.0         52.0
               C       3     62.818       72.70     18.483         48.5         84.8
               F       6    200.591      125.00    187.137         26.0        510.0
               I       8      5.255        6.05      1.534          2.6          6.6
               K       1     20.000       20.00       .            20.0         20.0

---------------------------------------- SUBCAT=CLEANING & FINISHING   POLNAME=OAG ------------------------------------------

             PLANT     N   PLANT_AVG     MEDIAN       STD       MINIMUM     MAXIMUM

               A       2       4.000        4.0      0.000         4           4
               B       4       4.000        4.0      0.000         4           4
               C       3      11.250       18.0     15.567         0          31
               D       2       4.000        4.0      0.000         4           4
               F       4     133.047      318.5    335.582         3         684
               I       8      48.467       21.5     87.648         7         235
               K       1       4.000        4.0                    4           4

---------------------------------------- SUBCAT=CLEANING & FINISHING   POLNAME=TSS ------------------------------------------

             PLANT     N   PLANT_AVG     MEDIAN       STD       MINIMUM     MAXIMUM

               A       2       33.60       25.5      19.09        12          39
               B       4        4.00        4.0       0.00         4           4
               C       3        6.20        8.0       4.58         2          11
               D       2       10.50       10.5       3.54         8          13
               F       6      234.80      236.0     468.07        68        1310
               I       8     6752.14     5748.0    6093.45       244       16363
               K       1        6.00        5.0                    6           6

---------------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=BOD ------------------------------------

             PLANT      N   PLANT_AVG     MEDIAN        STD     MINIMUM     MAXIMUM

               B        2      5.000        5.0      0.000       5.0         5.0
               C        3     90.867       90.9      6.050      84.8        96.9
               E       12      5.364        6.1      2.917       0.5         9.4
               F        8      7.043        7.5      2.375       3.0        10.0
               G        2    137.333      110.5    113.844      30.0       191.0
               H        2    777.500      777.5    208.597     630.0       925.0
               J        2      8.419       29.5     34.648       5.0        54.0
               K        9      5.000        5.0      0.000       5.0         5.0
```

```
                    SUMMARY STATISTICS ON PMF DATA BY SUBCATEGORY, POLLTANT
                                  RAW CONCENTRATION(MG/L)
---------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=OAG ---------------------------------
PLANT        N    PLANT_AVG      MEDIAN        STD       MINIMUM      MAXIMUM

  B          2      4.1084         5.5        2.1213        4.0          7.0
  C          3     47.0000        41.0       25.5343       25.0         75.0
  D          1      4.0000         4.0         .            4.0          4.0
  E         12     20.1298        20.4        4.7887       11.8         27.8
  F          8      2.9293         3.5        2.1213        0.0          5.0
  G          2      4.0000         4.0        0.0000        4.0          4.0
  H          3      4.0000         4.0        0.0000        4.0          4.0
  J          2     14.4884        36.0       35.3553       11.0         61.0
  K          9      4.0000         4.0        0.0000        4.0          4.0

---------------------------------- SUBCAT=CONTACT COOLING & HEATING   POLNAME=TSS ---------------------------------
PLANT        N    PLANT_AVG      MEDIAN        STD       MINIMUM      MAXIMUM

  B          2      4.0000        4.00        0.0000        4            4.0
  C          3     66.3333       77.00       43.9811       18          104.0
  D          1      4.0000        4.00         .            4            4.0
  E         12      3.1241        3.00        0.9535        2            4.0
  F          8      2.5380        1.50        2.0000        1            6.0
  G          2     16.0000       13.00       12.7279        4           22.0
  H          2      7.2500        7.25        4.5962        4           10.5
  J          2      6.3023       20.50       23.3345        4           37.0
  K          9      4.0175        4.00        0.6667        4            6.0
```

APPENDIX II B

Summary Statistics for PMP Data

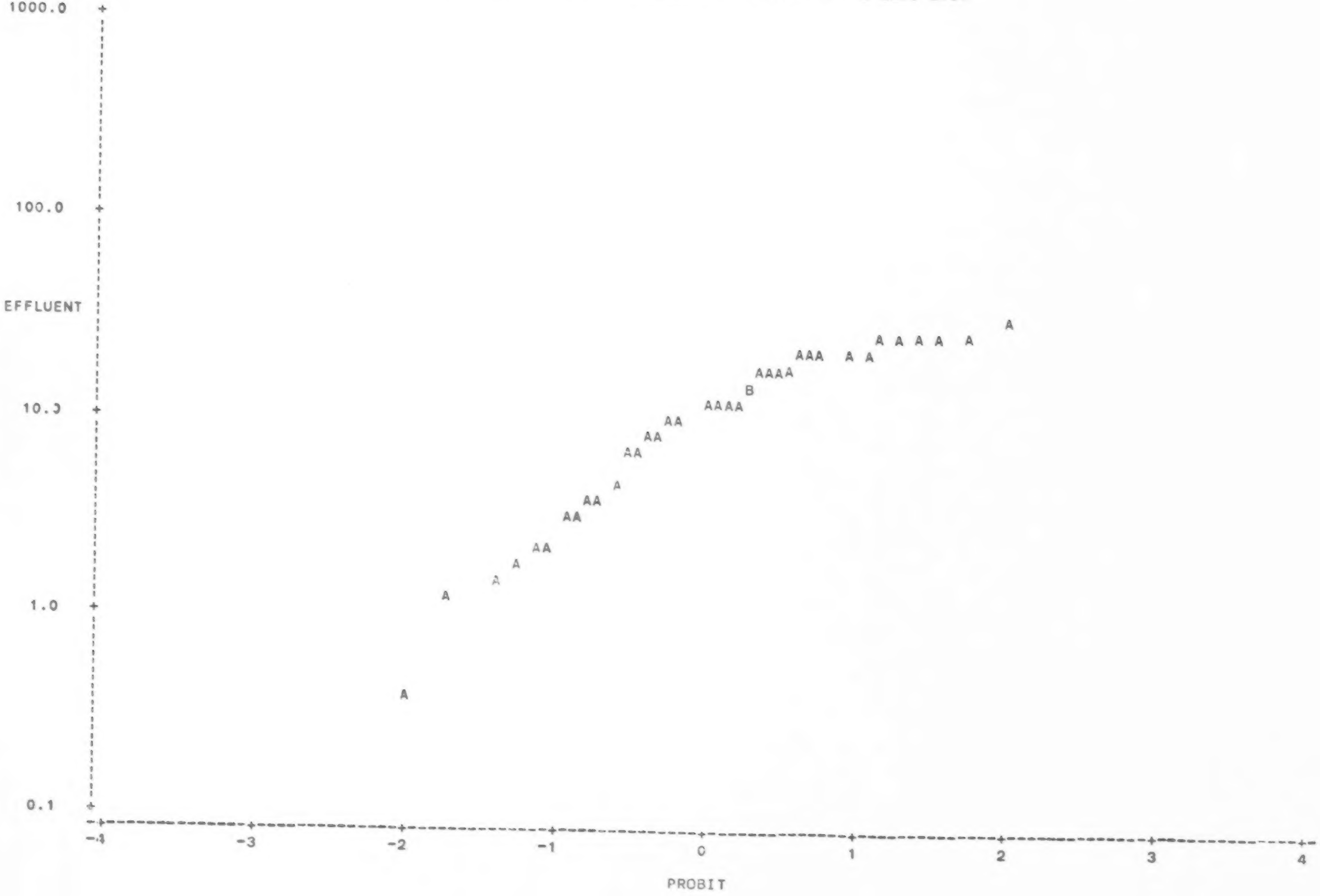
```
                              SUMMARY STATISTICS ON FMP DATA BY POLLUTANT
                               INFLUENT AND EFFLUENT CONCENTRATION(PPM)                                        1
------------------------------------------------------------ POLL=BOD ---------------------------------------------------------

PLANT   NINF    MEANINF   MEDINF    STDINF   MININF   MAXINF   NEFF   MEANEFF   MEDEFF    STDEFF   MINEFF   MAXEFF

   9      23      84.74       59    61.779        9      226     24   5.70833      5.0   2.83578      1.0       14
  44      45     754.00      710   259.794      225     1689    261   8.86590      8.0   5.04148      1.0       31
  45     148     381.14      369   132.375       55      760    156   3.04487      3.0   1.90532      1.0       12
  96       0          .        .         .        .        .    105   2.36190      2.0   1.87146      1.0       11
 111     157      94.82       95    38.166       24      340    157   6.19108      5.0   3.43462      2.0       20
 126     247    1087.47     1000   534.181      300     2600    249   5.96225      4.7   4.01444      0.6       20

------------------------------------------------------------ POLL=OAG ---------------------------------------------------------

PLANT   NINF    MEANINF   MEDINF    STDINF   MININF   MAXINF   NEFF   MEANEFF   MEDEFF    STDEFF   MINEFF   MAXEFF

   3     157    41.1385     22.0   40.0825      2.3    312.0     46   13.0261    12.25    8.5642      0.4       31
  61     234    17.3932     14.0   17.1321      2.0    230.0    348   14.5833    11.00   17.9715      1.0      260
 124      59    22.9017     17.3   19.0699      0.4    103.2    100    5.1670     2.65    7.1238      0.1       30
 170     203    79.2773     66.0   55.8855     12.0    409.0    163   10.7859     9.60    6.9133      0.6       39

------------------------------------------------------------ POLL=TSS ---------------------------------------------------------

PLANT   NINF    MEANINF   MEDINF    STDINF   MININF   MAXINF   NEFF   MEANEFF   MEDEFF    STDEFF   MINEFF   MAXEFF

   9      24      27.25     23.5     16.43        4       57     24   29.0917     20.5   15.1753      6.0       54
  44     249    3780.76   1040.0   7486.80       18    69600    260   14.4615      6.0   47.6527      1.0      200
  45     257     304.32    202.0    410.49        2     3758    364   17.9945     10.0   17.9430      2.0      110
  96       0          .        .         .        .        .     66   12.2273     10.5    8.3974      2.0 [illegible]
 111     148      42.84     40.0     16.82       10      100    347   10.0735      8.0    9.2436      0.5       71
 126     251     557.00    324.0   1155.43       64    14600    253   23.1344     20.0   14.1249      3.0 [illegible]
```

APPENDIX II C

Probit Plots for PMP Oil and Grease Data

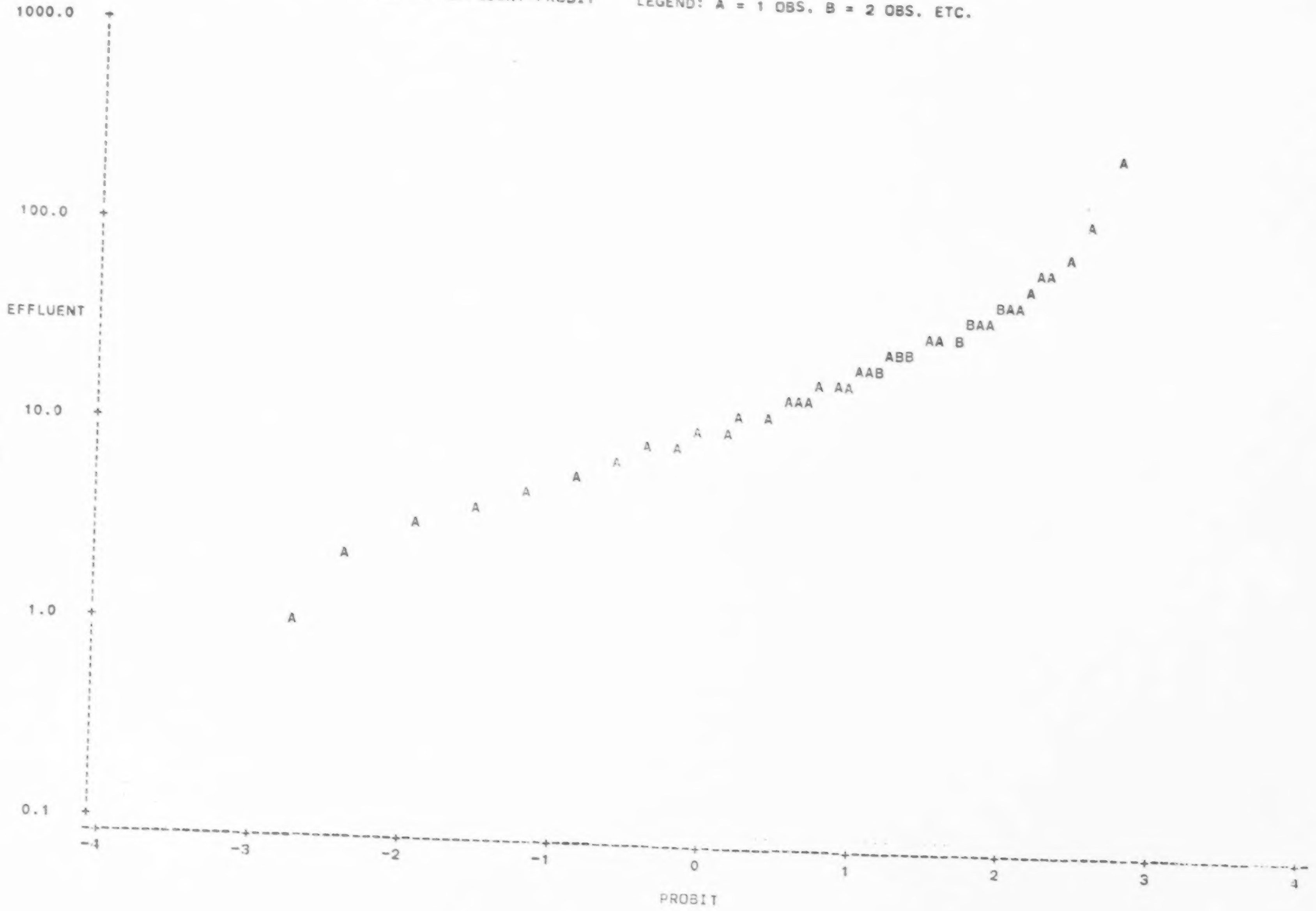
PROBABILITY PLOT OF OIL & GREASE(PPM)
PLANT=3

PLOT OF EFFLUENT*PROBIT   LEGEND: A = 1 OBS. B = 2 OBS. ETC.



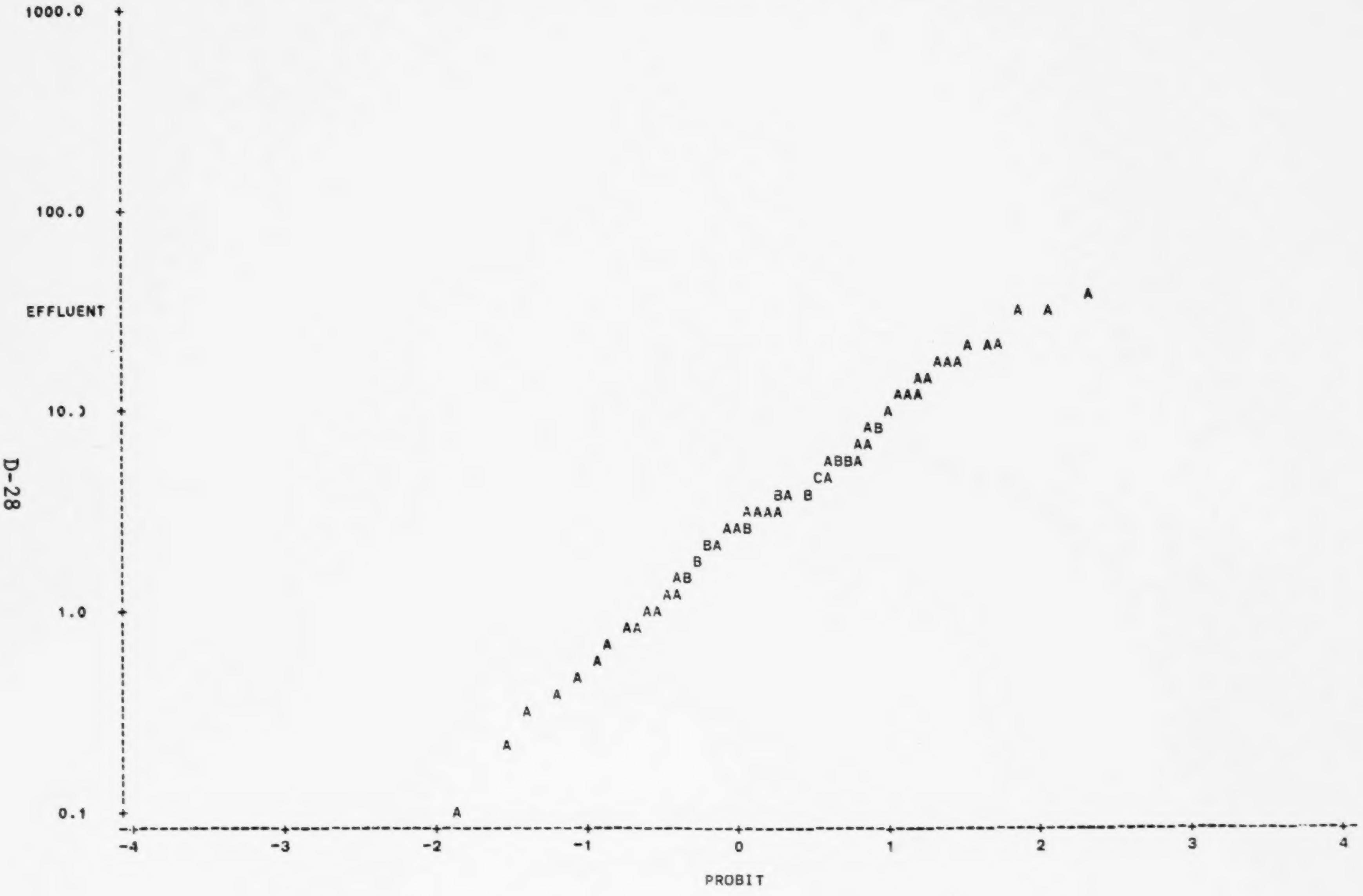
PROBABILITY PLOT OF OIL & GREASE(PPM)
PLANT=61

PLOT OF EFFLUENT*PROBIT   LEGEND: A = 1 OBS. B = 2 OBS. ETC.



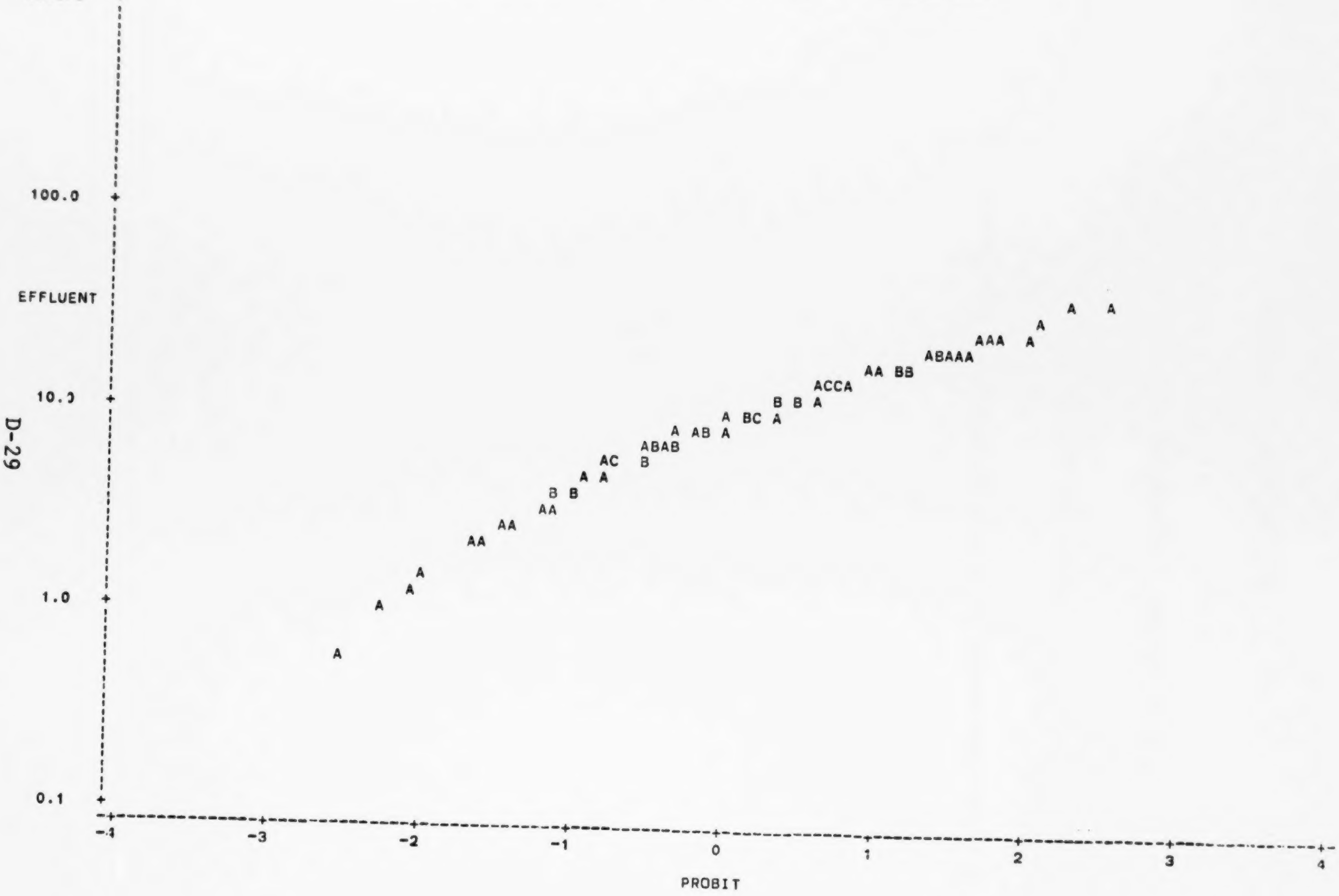
PROBABILITY PLOT OF OIL & GREASE(PPM)
PLANT=124

PLOT OF EFFLUENT*PROBIT   LEGEND: A = 1 OBS, B = 2 OBS, ETC.



PROBABILITY PLOT OF OIL & GREASE(PPM)
PLANT=170

PLOT OF EFFLUENT*PROBIT LEGEND: A = 1 OBS, B = 2 OBS. ETC.



DATA APPENDIX III CONTENTS

A. PM&F Sampling Program: Influent BOD, O&G, and TSS

B. PMP Data: Influent and Effluent BOD, O&G, and TSS

C. MP&F Questinnaire Survey Data for Production and Discharge Flow

APPENDIX III A

PM&F Sampling Program: Influent BOD, O&G, and TSS

LISTING OF PMF DATA

SUBCATEGORY=CLEANING & FINISHING

STREAM	POLLUTANT	DATE(DAY1)	FLOW(GPM) DAY1	CONCENTRATION DAY1(MG/L)	DATE(DAY2)	FLOW(GPM) DAY2	CONCENTRATION DAY2(MG/L)	DATE(DAY3)	FLOW(GPM) DAY3	CONCENTRATION DAY3(MG/L)
A-1	BOD	02/23/83	10.00	9.0	.	.	.	.	.	.
A-1	OAG	02/23/83	10.00	4.0	.	.	.	.	.	.
A-1	TSS	02/23/83	10.00	12.0	.	.	.	.	.	.
A-2	BOD	02/23/83	40.00	450.0	.	.	.	.	.	.
A-2	OAG	02/23/83	40.00	4.0	.	.	.	.	.	.
A-2	TSS	02/23/83	40.00	39.0	.	.	.	.	.	.
B-2	BOD	03/08/83	1.80	5.0	.	.	.	.	.	.
B-2	OAG	03/08/83	1.80	4.0	.	.	.	.	.	.
B-2	TSS	03/08/83	1.80	4.0	.	.	.	.	.	.
B-3	BOD	03/08/83	20.00	48.0	03/09/83	20.00	46.0	03/10/83	20.00	52.0
B-3	OAG	03/08/83	20.00	4.0	03/09/83	20.00	4.0	03/10/83	20.00	4.0
B-3	TSS	03/08/83	20.00	4.0	03/09/83	20.00	4.0	03/10/83	20.00	4.0
C-2	BOD	10/28/80	0.90	84.8	10/29/80	2.90	48.5	10/30/80	2.20	72.7
C-2	OAG	10/28/80	0.90	31.0	10/29/80	2.90	0.0	10/30/80	2.20	18.0
C-2	TSS	10/28/80	0.90	8.0	10/29/80	2.90	2.0	10/30/80	2.20	11.0
D-1	OAG	02/08/83	15.00	4.0	.	.	.	.	.	.
D-1	TSS	02/08/83	15.00	13.0	.	.	.	.	.	.
D-2	OAG	02/08/83	15.00	4.0	.	.	.	.	.	.
D-2	TSS	02/08/83	15.00	8.0	.	.	.	.	.	.
F-3	BOD	10/28/80	3.40	510.0	10/29/80	2.30	247.0	10/30/80	4.90	52.0
F-3	OAG	10/28/80	3.40	548.0	10/29/80	2.30	684.0	.	.	.
F-3	TSS	10/28/80	3.40	198.0	10/29/80	2.30	274.0	10/30/80	4.90	466.0
F-4	BOD	10/28/80	20.00	198.0	10/29/80	1.75	34.0	10/30/80	0.50	26.0
F-4	OAG	10/28/80	20.00	3.0	10/29/80	1.75	89.0	.	.	.
F-4	TSS	10/28/80	20.00	90.0	10/29/80	1.75	1310.0	10/30/80	0.50	68.0
I-1	BOD	11/17/80	1.00	6.3	11/18/80	1.57	6.1	11/19/80	1.51	6.2
I-1	OAG	11/17/80	1.00	18.0	11/18/80	1.57	7.0	11/19/80	1.51	45.0
I-1	TSS	11/17/80	1.00	16363.0	11/18/80	1.57	11738.0	11/19/80	1.51	12597.0
I-2	BOD	11/17/80	0.78	2.6	11/18/80	0.34	6.0	11/19/80	1.03	5.7
I-2	OAG	11/17/80	0.78	235.0	11/18/80	0.34	22.0	11/19/80	1.03	174.0
I-2	TSS	11/17/80	0.78	5825.0	11/18/80	0.34	244.0	11/19/80	1.03	1039.0
I-3	BOD	11/17/80	1.78	3.2	.	.	.	11/19/80	1.51	6.6
I-3	OAG	11/17/80	1.78	21.0	.	.	.	11/19/80	1.51	8.0
I-3	TSS	11/17/80	1.78	1136.0	.	.	.	11/19/80	1.51	5671.0
K-1	BOD	02/14/83	0.50	20.0	.	.	.	.	.	.
K-1	OAG	02/14/83	0.50	4.0	.	.	.	.	.	.
K-1	TSS	02/14/83	0.50	6.0	.	.	.	.	.	.

SUBCATEGORY=CONTACT COOLING & HEATING

STREAM	POLLUTANT	DATE(DAY1)	FLOW(GPM) DAY1	CONCENTRATION DAY1(MG/L)	DATE(DAY2)	FLOW(GPM) DAY2	CONCENTRATION DAY2(MG/L)	DATE(DAY3)	FLOW(GPM) DAY3	CONCENTRATION DAY3(MG/L)
B-1	BOD	03/08/83	0.80	5.0	.	.	.	.	.	.
B-1	OAG	03/08/83	0.80	4.0	.	.	.	.	.	.
B-1	TSS	03/08/83	0.80	4.0	.	.	.	.	.	.
B-4	BOD	03/08/83	0.03	5.0	.	.	.	.	.	.
B-4	OAG	03/08/83	0.03	7.0	.	.	.	.	.	.
B-4	TSS	03/08/83	0.03	4.0	.	.	.	.	.	.
C-1	BOD	10/28/80	0.28	96.9	10/29/80	0.28	84.8	10/30/80	0.28	90.9
C-1	OAG	10/28/80	0.28	75.0	10/29/80	0.28	25.0	10/30/80	0.28	41.0
C-1	TSS	10/28/80	0.28	104.0	10/29/80	0.28	77.0	10/30/80	0.28	18.0

LISTING OF PMF DATA

SUBCATEGORY=CONTACT COOLING & HEATING

STREAM	POLLUTANT	DATE(DAY1)	FLOW(GPM) DAY1	CONCENTRATION DAY1(MG/L)	DATE(DAY2)	FLOW(GPM) DAY2	CONCENTRATION DAY2(MG/L)	DATE(DAY3)	FLOW(GPM) DAY3	CONCENTRATION DAY3(MG/L)
D-3	OAG	02/08/83	50.00	4.0	.	.	.	.	.	.
D-3	TSS	02/08/83	50.00	4.0	.	.	.	.	.	.
E-1	BOD	10/07/80	5.00	7.2	10/08/80	5.00	6.1	10/09/80	5.00	2.5
E-1	OAG	10/07/90	5.00	20.8	10/08/80	5.00	13.6	10/09/80	5.00	23.0
E-1	TSS	10/07/80	5.00	2.0	10/08/80	5.00	4.0	10/09/80	5.00	2.0
E-2	BOD	10/07/80	14.00	9.4	10/08/80	14.00	8.9	10/09/80	14.00	4.1
E-2	OAG	10/07/80	14.00	16.8	10/08/80	14.00	23.8	10/09/80	14.00	11.8
E-2	TSS	10/07/80	14.00	3.0	10/08/80	14.00	4.0	10/09/80	14.00	2.0
E-3	BOD	10/07/80	35.00	7.6	10/08/80	35.00	3.9	10/09/80	35.00	0.5
E-3	OAG	10/07/80	35.00	20.0	10/08/80	35.00	27.8	10/09/80	35.00	19.4
E-3	TSS	10/07/80	35.00	4.0	10/08/80	35.00	2.0	10/09/80	35.00	3.0
E-4	BOD	10/07/80	40.00	8.9	10/08/80	40.00	6.1	10/09/80	40.00	2.5
E-4	OAG	10/07/80	40.00	21.0	10/08/80	40.00	13.6	10/09/80	40.00	23.0
E-4	TSS	10/07/80	40.00	4.0	10/08/80	40.00	4.0	10/09/80	40.00	2.0
F-1	BOD	10/28/80	2.50	10.0	10/29/80	2.00	8.0	10/30/80	2.50	10.0
F-1	OAG	10/28/80	2.50	1.0	10/29/80	2.00	0.0	10/30/80	2.50	4.0
F-1	TSS	10/28/80	2.50	6.0	10/29/80	2.00	3.0	10/30/80	2.50	5.0
F-2	BOD	10/28/80	1.80	8.0	10/29/80	1.80	7.0	10/30/80	1.80	7.0
F-2	OAG	10/28/80	1.80	3.0	10/29/80	1.80	0.0	10/30/80	1.80	5.0
F-2	TSS	10/28/80	1.80	1.0	10/29/80	1.80	2.0	10/30/80	1.80	1.0
F-6	BOD	.	.	.	10/29/80	2.00	5.0	10/30/80	2.00	3.0
F-6	OAG	.	.	.	10/29/80	2.00	5.0	10/30/80	2.00	4.0
F-6	TSS	.	.	.	10/29/80	2.00	1.0	10/30/80	2.00	1.0
G-1	BOD	02/07/83	1.80	131.0	02/08/83	0.90	30.0	.	.	.
G-1	OAG	02/07/83	1.80	4.0	02/08/83	0.90	4.0	.	.	.
G-1	TSS	02/07/83	1.80	22.0	02/08/83	0.90	4.0	.	.	.
H-1	BOD	02/24/83	0.07	925.0	02/25/83	0.07	630.0	02/26/83	0.07	4.0
H-1	OAG	02/24/83	0.07	4.0	02/25/83	0.07	4.0	.	.	.
H-1	TSS	02/24/83	0.07	10.5	02/25/83	0.07	4.0	.	.	.
J-1	BOD	03/29/83	120.00	5.0	.	.	.	.	.	.
J-1	OAG	03/29/83	120.00	11.0	.	.	.	.	.	.
J-1	TSS	03/29/83	120.00	4.0	.	.	.	.	.	.
J-2	BOD	03/29/83	9.00	54.0	.	.	.	.	.	.
J-2	OAG	03/29/83	9.00	61.0	.	.	.	.	.	.
J-2	TSS	03/29/83	9.00	37.0	.	.	.	.	.	.
K-2	BOD	02/14/83	4.00	5.0	02/15/83	4.00	5.0	02/16/83	4.00	5.0
K-2	OAG	02/14/83	4.00	4.0	02/15/83	4.00	4.0	02/16/83	4.00	4.0
K-2	TSS	02/14/83	4.00	6.0	02/15/83	4.00	4.0	02/16/83	4.00	4.0
K-3	BOD	02/14/83	2.00	5.0	02/15/83	2.00	5.0	02/16/83	2.00	5.0
K-3	OAG	02/14/83	2.00	4.0	02/15/83	2.00	4.0	02/16/83	2.00	4.0
K-3	TSS	02/14/83	2.00	4.0	02/15/83	2.00	4.0	02/16/83	2.00	4.0
K-4	BOD	02/14/83	167.00	5.0	02/15/83	146.00	5.0	02/16/83	125.00	5.0
K-4	OAG	02/14/83	167.00	4.0	02/15/83	146.00	4.0	02/16/83	125.00	4.0
K-4	TSS	02/14/83	167.00	4.0	02/15/83	146.00	4.0	02/16/83	125.00	4.0

APPENDIX III B

PMP Data: Influent and Effluent BOD, O&G and TSS

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                         LISTING OF PMP DATA BY POLLUTANT

-------------------------------------- POLL=BOD ---------------------------------------

         OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

           1      9     101575      0.05             56               4
           2      9     102275      0.05             70               5
           3      9     111275      0.25            194               5
           4      9     111975      0.07             54               1
           5      9     121075      0.06             49               5
           6      9     121775      0.06             32               5
           7      9     010776      0.10             71              14
           8      9     011476       .              120               5
           9      9     021176      0.07             59               4
          10      9     021876       .              226               2
          11      9     031076      0.08             52               7
          12      9     032576       .                .               7
          13      9     041476      0.06             20               4
          14      9     042176       .              108               8
          15      9     051276      0.09            192               4
          16      9     051976       .               17               8
          17      9     060976      0.13             56               3
          18      9     061676      0.13             54               6
          19      9     072176      0.07             92              10
          20      9     072876      0.09             80               7
          21      9     080476      0.05              9               4
          22      9     081876      0.06            132              10
          23      9     090876      0.02             27               4
          24      9     092276       .              179               5
          25     44     060179      0.92              .              13
          26     44     060479      0.88              .               6
          27     44     060579      1.00              .              14
          28     44     060679      0.80              .              15
          29     44     060779      0.38              .               9
          30     44     060879      0.83              .              16
          31     44     061179      0.94              .               4
          32     44     061279      0.79              .               5
          33     44     061379      0.80              .              18
          34     44     061479      1.13              .              18
          35     44     061579      0.45              .              17
          36     44     061879      0.57              .               1
          37     44     061979      0.71              .              16
          38     44     062079      0.39              .              17
          39     44     062179      0.57              .              16
          40     44     062279      0.36              .              14
          41     44     062579      0.83              .               3
          42     44     062679      0.68              .              13
          43     44     062779      0.60              .              12
          44     44     062879      0.62              .              10
          45     44     062979      0.60              .              14
          46     44     070279      0.81              .               2
          47     44     070379      0.63           1000               5
          48     44     070479      0.51              .              10
          49     44     070579      0.25              .              10
          50     44     070679      0.34              .              13
          51     44     070979      0.79              .               8
          52     44     071079      0.71              .              17
          53     44     071179      0.73              .               8
          54     44     071279      0.74              .              27
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                                   LISTING OF PMP DATA BY POLLUTANT

----------------------------------------------------- POLL=BOD -----------------------------------------------------

                OBS     PLANT     DATE     FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

                 55       44     071379      0.80               .                14
                 56       44     071679      0.74               .                 7
                 57       44     071779      0.79               .                 8
                 58       44     071879      0.73               .                 3
                 59       44     071979      0.73               .                15
                 60       44     072079      0.90               .                22
                 61       44     072379      0.54               .                 5
                 62       44     072479      0.69               .                 4
                 63       44     072579      0.73               .                15
                 64       44     072679      0.81               .                29
                 65       44     072779      0.71               .                22
                 66       44     073079      0.79               .                 4
                 67       44     073179      0.43               .                11
                 68       44     080179      0.38             769                 4
                 69       44     080279      0.46               .                 7
                 70       44     080379      0.66               .                 4
                 71       44     080679      0.74               .                 5
                 72       44     080779      0.26               .                 6
                 73       44     080879      0.56            1090                13
                 74       44     080979      0.73               .                 9
                 75       44     081079      0.75               .                 9
                 76       44     081379      0.74               .                 7
                 77       44     081479      0.65               .                24
                 78       44     081579      0.79            1689                16
                 79       44     081679      0.73               .                20
                 80       44     081779      0.84               .                21
                 81       44     082079      0.83               .                10
                 82       44     082179      0.85               .                22
                 83       44     082279      0.73            1311                13
                 84       44     082379      0.67               .                31
                 85       44     082479      0.94               .                21
                 86       44     082779      0.96               .                 3
                 87       44     082879      0.96               .                15
                 88       44     082979      0.91             700                13
                 89       44     083079      0.90               .                14
                 90       44     083179       .                 .                 9
                 91       44     090379      0.19             622                 7
                 92       44     090479      0.34               .                 5
                 93       44     090579      0.28               .                 7
                 94       44     090679      0.38               .                 8
                 95       44     090779      0.33               .                 9
                 96       44     091079      0.62               .                11
                 97       44     091179      0.70               .                13
                 98       44     091279      0.67               .                 9
                 99       44     091379      0.72               .                13
                100       44     091479      0.85               .                13
                101       44     091779      0.88             304                11
                102       44     091879      0.88               .                13
                103       44     091979      0.48             648                 5
                104       44     092079      0.33               .                 4
                105       44     092179      0.43               .                 4
                106       44     092479      0.31             225                 5
                107       44     092579      0.27               .                 3
                108       44     092679      0.37               .                 3
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                                          LISTING OF PMP DATA BY POLLUTANT                                              3
------------------------------------------------------------ POLL=BOD ------------------------------------------------------------
                          OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                          109     44      092779      0.36              .                8
                          110     44      092879      0.35              .                9
                          111     44      100179      0.55            794                7
                          112     44      100279      0.57              .                8
                          113     44      100379      0.45              .                8
                          114     44      100479      0.36              .                6
                          115     44      100579      0.57              .                7
                          116     44      100879      0.96            806                4
                          117     44      100979      0.46              .                7
                          118     44      101079      0.64              .                9
                          119     44      101179      0.70              .                6
                          120     44      101279      0.68              .                6
                          121     44      101579      0.23            500                3
                          122     44      101679      0.67              .                8
                          123     44      101779      0.67              .                6
                          124     44      101879      0.60              .                5
                          125     44      101979      0.62              .                8
                          126     44      102279      0.60            369                3
                          127     44      102379      0.68              .                7
                          128     44      102479      0.69              .                6
                          129     44      102579      0.60              .               11
                          130     44      102679      0.59              .                8
                          131     44      102979      0.60              .               10
                          132     44      103079      0.67              .               17
                          133     44      103179      0.10              .               18
                          134     44      110179      0.52           1019               11
                          135     44      110279      0.72              .               11
                          136     44      110579      0.58              .                4
                          137     44      110679      0.59              .                7
                          138     44      110779      0.68              .                9
                          139     44      110879      0.68            816               10
                          140     44      110979      0.53              .                9
                          141     44      111279      0.66              .               11
                          142     44      111379      0.98              .                9
                          143     44      111479      0.65              .               11
                          144     44      111579      0.51            781                8
                          145     44      111679      0.51              .               11
                          146     44      111979      0.72              .               15
                          147     44      112079      0.78              .               15
                          148     44      112179      0.78              .               12
                          149     44      112279      0.35            906               14
                          150     44      112379      0.11              .                5
                          151     44      112679      0.59              .                5
                          152     44      112779      0.78              .                5
                          153     44      112879      0.69              .                5
                          154     44      112979      0.70            925               13
                          155     44      113079      0.79              .                6
                          156     44      120379      0.74            654                1
                          157     44      120479      0.55              .                7
                          158     44      120579      0.60              .                6
                          159     44      120679      0.66              .                4
                          160     44      120779      0.70              .                4
                          161     44      121079      1.12            721                5
                          162     44      121179      0.63              .               14
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                                   LISTING OF FMP DATA BY POLLUTANT

---------------------------------------------------- POLL=BOD --------------------------------------------------------------

                 OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                 163     44      121279      0.79             .                4
                 164     44      121379      0.60             .                3
                 165     44      121479      0.63             .                5
                 166     44      121779      0.61           956                3
                 167     44      121879      0.58             .                4
                 168     44      121979      0.57             .                5
                 169     44      122079      0.52             .                5
                 170     44      122179      0.65             .                8
                 171     44      122479      0.36          1020                9
                 172     44      122579      0.47             .               14
                 173     44      122679      0.41             .               10
                 174     44      122779      0.30             .                7
                 175     44      122879      0.41             .                8
                 176     44      123179      0.63             .                6
                 177     44      010180      0.53           697               15
                 178     44      010280      0.15             .               20
                 179     44      010380      0.59             .               10
                 180     44      010480      0.50             .               13
                 181     44      010780      0.67           587               14
                 182     44      010880      0.63          1157                7
                 183     44      010980      0.65             .                5
                 184     44      011080      0.47             .                6
                 185     44      011180      0.69             .                8
                 186     44      011480      0.32             .                3
                 187     44      011580      0.60           722               13
                 188     44      011680      0.76             .                7
                 189     44      011780      0.74             .               10
                 190     44      011880      0.56             .               11
                 191     44      012180      0.62             .                3
                 192     44      012280      0.60          1010               10
                 193     44      012380      0.65             .               14
                 194     44      012480      0.53             .               12
                 195     44      012580      0.61             .               11
                 196     44      012880      0.53             .                5
                 197     44      012980      0.48             .               10
                 198     44      013080      0.43             .                9
                 199     44      013180      0.54             .                6
                 200     44      020180      0.67           611                5
                 201     44      020480      0.67             .               12
                 202     44      020580      0.55             .                8
                 203     44      020680      0.43             .                6
                 204     44      020780      0.46             .                5
                 205     44      020880      0.94           802               10
                 206     44      021180      0.69             .                5
                 207     44      021280      0.25             .                6
                 208     44      021380      0.51             .               10
                 209     44      021480      0.63             .                7
                 210     44      021580      0.57           855                8
                 211     44      021880      0.47             .               10
                 212     44      021980      0.65             .               14
                 213     44      022080      0.69             .               13
                 214     44      022180      0.74             .               13
                 215     44      022280      0.71           590               15
                 216     44      022580      0.89             .                6
```

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                                   LISTING OF FMP DATA BY POLLUTANT
                                                                                                      5
------------------------------------------------------ POLL=BOD ----------------------------------------

          OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

          217     44      022680      0.85             .                9
          218     44      022780      0.78             .                6
          219     44      022880      0.58             .                3
          220     44      022980      0.46             .                3
          221     44      030380      0.44           710                9
          222     44      030480      0.50             .                9
          223     44      030580      0.57             .                5
          224     44      030680      0.61             .               12
          225     44      030780      1.04             .                7
          226     44      031080      0.79           666               10
          227     44      031180      0.64             .                8
          228     44      031280      0.63             .                8
          229     44      031380      0.82             .                9
          230     44      031480      0.80             .                8
          231     44      031780      0.91           599                8
          232     44      031880      0.86             .                7
          233     44      031980      0.82             .                3
          234     44      032080      1.00             .                8
          235     44      032180      0.97             .                8
          236     44      032480      0.62           618                4
          237     44      032580      0.78             .                3
          238     44      032680      0.75             .                3
          239     44      032780      0.71             .                3
          240     44      032880      0.82             .                3
          241     44      033180      0.73             .                3
          242     44      040180      0.61           552               12
          243     44      040280      0.82             .                3
          244     44      040380      0.56             .                7
          245     44      040480      0.21             .               10
          246     44      040780      0.64             .                4
          247     44      040880      0.90           736                3
          248     44      040980      0.71             .                3
          249     44      041080      0.92             .                3
          250     44      041180      0.93             .                3
          251     44      041480      0.95             .                3
          252     44      041580      0.70           583                3
          253     44      041680      0.74             .                7
          254     44      041760      0.87             .                6
          255     44      041880      0.86             .                3
          256     44      042180      0.76             .                4
          257     44      042280      0.55           549                5
          258     44      042380      0.73             .                3
          259     44      042480      0.73             .                3
          260     44      042580      0.59             .                3
          261     44      042880      0.62             .                4
          262     44      042980      0.60             .                6
          263     44      043080      0.62             .                7
          264     44      050180      0.70           675                4
          265     44      050280      0.67             .                4
          266     44      050580      0.87             .                5
          267     44      050680      0.96             .               10
          268     44      050780      0.37             .               14
          269     44      050880      0.32           911               13
          270     44      050980      0.60             .               15
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                                          LISTING OF PMP DATA BY POLLUTANT                                                  6
------------------------------------------------------------- POLL=BOD ----------------------------------------------------------
                           OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                           271     44     051280      0.72             .                8
                           272     44     051380      0.80             .               12
                           273     44     051480      0.64             .               11
                           274     44     051580      0.35           555                9
                           275     44     051680      0.60             .                9
                           276     44     051980      0.50             .                5
                           277     44     052080      0.25             .                8
                           278     44     052180      0.11             .                9
                           279     44     052280      0.57           576               11
                           280     44     052380      0.44             .               11
                           281     44     052680      0.30             .                7
                           282     44     052780      0.48             .                6
                           283     44     052880      0.54             .                7
                           284     44     052980       .             544               10
                           285     44     053080       .               .                5
                           286     45     062879      3.31           350                1
                           287     45     070379      1.73           360                2
                           288     45     070479      1.46           308                2
                           289     45     070579      2.13           175                2
                           290     45     071079      2.35           368               11
                           291     45     071179      2.84           325                7
                           292     45     071279      2.95           288                5
                           293     45     071779      2.07           278                2
                           294     45     071879      2.43           280                2
                           295     45     071979      2.70           338                2
                           296     45     072479      3.49           310                5
                           297     45     072579      3.17           375                6
                           298     45     072679      3.26           393                5
                           299     45     073179      3.12             .                1
                           300     45     080179      3.03           165                2
                           301     45     080279      2.87           170                3
                           302     45     080779      2.94           245                1
                           303     45     080879      3.04           205                1
                           304     45     080979      2.48           283                2
                           305     45     081479      2.71             .                1
                           306     45     081579      2.56           358                5
                           307     45     081679      2.82           458                1
                           308     45     082179      3.41           315                4
                           309     45     082279      3.62           325                3
                           310     45     082379      3.55           403                2
                           311     45     082879      2.63           325                3
                           312     45     082979      2.56           308                2
                           313     45     083079      3.40           372                1
                           314     45     090479      1.61           195                2
                           315     45     090579      2.21           240                1
                           316     45     090679      2.86           200                2
                           317     45     091179      2.44           293                2
                           318     45     091279      1.92           313                1
                           319     45     091379      1.85           240                2
                           320     45     091879      2.39           331                1
                           321     45     091979      1.86           323                2
                           322     45     092079      3.04           313                2
                           323     45     092579      2.85           345                1
                           324     45     092679      2.77           325                1
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                                   LISTING OF PMP DATA BY POLLUTANT

---------------------------------------------------- POLL=BOD --------------------------------------------------------

                 OBS    PLANT     DATE     FLOW(MGD)   INFLUENT(PPM)    EFFLUENT(PPM)

                 325     45      092779       2.52          298              1
                 326     45      100279       2.24          288              2
                 327     45      100379       2.27          255              2
                 328     45      100479       2.66          288              3
                 329     45      100979       2.19          353              4
                 330     45      101079       2.52          420              2
                 331     45      101679       2.10            .              5
                 332     45      101779       1.95          468              4
                 333     45      101879       1.42          479              3
                 334     45      102379       2.26            .              6
                 335     45      102479       1.22            .              8
                 336     45      102579       1.55            .              2
                 337     45      103079       2.26            .              3
                 338     45      103179       1.86          320              3
                 339     45      110179       1.56          345              2
                 340     45      110679       1.59          395              5
                 341     45      110779       1.57          520              5
                 342     45      110879       1.73          425              3
                 343     45      111379       2.17          570              6
                 344     45      111479       1.41          678              4
                 345     45      111579       1.19          435              3
                 346     45      112079       1.65          385              2
                 347     45      112179       1.49          410              3
                 348     45      112279       0.96          430              3
                 349     45      112779       1.36          260              1
                 350     45      112879       1.48          303              1
                 351     45      112979       2.01          330              5
                 352     45      120479       1.36          273              1
                 353     45      120579       1.98          400              4
                 354     45      120679       1.54          315              3
                 355     45      121179       2.12          425              4
                 356     45      121279       2.03          477              6
                 357     45      121379       2.21          528              3
                 358     45      121879       2.09          487              4
                 359     45      121979       2.20          360              6
                 360     45      122079       2.22          513              3
                 361     45      122579       1.04          330              4
                 362     45      122679       1.65          320              4
                 363     45      122779       2.09          305              4
                 364     45      010180       0.74          430              3
                 365     45      010280       2.06          483              4
                 366     45      010380       1.93          482              6
                 367     45      010880       1.61          545              4
                 368     45      010980       1.74          660              3
                 369     45      011080       1.60          680              4
                 370     45      011580       1.59          450              4
                 371     45      011680       1.55          344              6
                 372     45      011780       1.53          365              2
                 373     45      012280       1.72          550             12
                 374     45      012380       1.91          760              4
                 375     45      012480       1.47          495              3
                 376     45      012980       1.60          510              5
                 377     45      013080       1.66          495              9
                 378     45      013180       1.64          518              6
```

LISTING OF FMP DATA BY POLLUTANT

POL.=BOD

OBS	PLANT	DATE	FLOW(MGD)	INFLUENT(PPM)	EFFLUENT(PPM)
379	45	020580	1.64	570	3
380	45	020680	1.48	475	7
381	45	020780	1.58	378	3
382	45	021280	2.02	390	4
383	45	021380	2.15	533	3
384	45	021480	1.92	513	2
385	45	021980	1.93	465	3
386	45	022080	2.13	425	3
387	45	022180	1.66	645	2
388	45	022680	1.40	470	5
389	45	022780	1.70	.	3
390	45	022880	1.06	455	3
391	45	030480	1.57	593	3
392	45	030580	1.72	497	3
393	45	030680	1.55	472	3
394	45	031180	2.58	583	6
395	45	031280	2.20	492	4
396	45	031380	2.05	542	3
397	45	031880	2.03	595	2
398	45	031980	2.23	690	2
399	45	032080	2.40	508	4
400	45	032580	1.55	540	3
401	45	032680	1.68	458	4
402	45	032780	1.67	483	3
403	45	040180	2.07	410	3
404	45	040280	1.54	420	2
405	45	040380	1.53	588	3
406	45	040880	1.85	493	3
407	45	040980	1.86	473	4
408	45	041080	1.83	370	3
409	45	041580	1.67	330	1
410	45	041680	2.80	535	1
411	45	041780	2.51	440	2
412	45	042280	2.01	425	4
413	45	042380	1.93	410	1
414	45	042480	1.44	413	2
415	45	042980	1.76	475	1
416	45	043080	2.05	310	1
417	45	050180	1.72	323	1
418	45	050680	1.91	468	5
419	45	050780	2.30	368	5
420	45	050880	2.14	333	5
421	45	051380	1.88	343	2
422	45	051480	1.93	390	1
423	45	051580	1.53	435	2
424	45	052080	1.23	305	1
425	45	052180	1.17	330	2
426	45	052280	0.87	230	1
427	45	052780	1.30	55	3
428	45	052880	1.67	79	1
429	45	052980	0.99	128	1
430	45	060380	1.01	116	3
431	45	060480	0.93	160	3
432	45	060580	0.90	140	3

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                                        LISTING OF IMP DATA BY POLLUTANT
------------------------------------------------------------ POL =BOD ----------------------------------------------------------- 9
                   OBS     PLANT      DATE      FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

                   433      45       061080       1.45             215                1
                   434      45       061180       1.48             210                1
                   435      45       061280       1.66             210                1
                   436      45       061780       1.34             100                1
                   437      45       061880       1.41             195                1
                   438      45       061980       1.45             170                2
                   439      45       062480       1.26             293                1
                   440      45       062580       1.21             270                1
                   441      45       062680       1.64             320                2
                   442      96       093075       3.20              .                 5
                   443      96       100375       3.20              .                 4
                   444      96       100775       3.20              .                 4
                   445      96       101075       3.10              .                11
                   446      96       101475       3.10              .                 9
                   447      96       101775       3.20              .                 5
                   448      96       102175       3.00              .                 6
                   449      96       102475       3.20              .                 8
                   450      96       102875       3.20              .                 8
                   451      96       110175       3.20              .                 6
                   452      96       110475       3.40              .                 1
                   453      96       110775       3.40              .                 1
                   454      96       111175       3.10              .                 2
                   455      96       111475       3.10              .                 2
                   456      96       111875       3.40              .                 2
                   457      96       112175       3.40              .                 1
                   458      96       112475       3.40              .                 1
                   459      96       112775       3.30              .                 2
                   460      96       120175       3.30              .                 2
                   461      96       120475       3.30              .                 2
                   462      96       120875       3.40              .                 1
                   463      96       121175       3.20              .                 1
                   464      96       121575       3.00              .                 2
                   465      96       121875       3.10              .                 2
                   466      96       122275       3.30              .                 1
                   467      96       122575       3.50              .                 3
                   468      96       122975       3.50              .                 3
                   469      96       010176       3.50              .                 2
                   470      96       010576       3.60              .                 3
                   471      96       010876       3.50              .                 2
                   472      96       011276       3.60              .                 2
                   473      96       011576       3.50              .                 3
                   474      96       012076       3.40              .                 9
                   475      96       012276       3.20              .                 3
                   476      96       012676       3.30              .                 5
                   477      96       012976       3.20              .                 2
                   478      96       020276       3.20              .                 2
                   479      96       020576       3.30              .                 3
                   480      96       020976       3.20              .                 2
                   481      96       021276       3.50              .                 1
                   482      96       021676       3.50              .                 1
                   483      96       021976       3.20              .                 3
                   484      96       022376       3.50              .                 2
                   485      96       022676       3.20              .                 1
                   486      96       030176       3.40              .                 2
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                                LISTING OF PMP DATA BY POLLUTANT                                                         10
-------------------------------------------------------------------- POLL=BOD ----------------------------------------------------------------

                  OBS     PLANT      DATE      FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                  487      96       030476        3.4             .                3
                  488      96       030876        3.3             .                1
                  489      96       031176        3.1             .                2
                  490      96       031576        3.5             .                3
                  491      96       031876        3.2             .                3
                  492      96       032276        3.2             .                1
                  493      96       032676        3.2             .                2
                  494      96       033076        3.1             .                2
                  495      96       040176        3.2             .                2
                  496      96       040576        3.4             .                2
                  497      96       040876        3.1             .                2
                  498      96       041276        3.0             .                1
                  499      96       041576        3.8             .                2
                  500      96       041976        3.5             .                2
                  501      96       042276        3.2             .                1
                  502      96       042676        3.0             .                2
                  503      96       042976        3.0             .                3
                  504      96       050376        3.1             .                3
                  505      96       050676        3.2             .                1
                  506      96       051076        3.1             .                2
                  507      96       051376        3.0             .                1
                  508      96       051776        3.2             .                3
                  509      96       052076        3.0             .                1
                  510      96       052476        3.0             .                2
                  511      96       052776        2.9             .                1
                  512      96       053176        3.1             .                1
                  513      96       060376        3.0             .                1
                  514      96       060776        3.0             .                4
                  515      96       061076        3.1             .                3
                  516      96       061476        3.2             .                3
                  517      96       061776        3.1             .                4
                  518      96       062176        3.1             .                2
                  519      96       062476        2.9             .                2
                  520      96       062876        2.9             .                2
                  521      96       070176        3.4             .                1
                  522      96       070576        3.1             .                2
                  523      96       070876        3.0             .                1
                  524      96       071276        3.0             .                2
                  525      96       071576        3.0             .                1
                  526      96       071976        3.0             .                2
                  527      96       072276        2.8             .                1
                  528      96       072676        2.9             .                1
                  529      96       072976        2.8             .                1
                  530      96       080276        2.8             .                2
                  531      96       080576        2.7             .                2
                  532      96       080976        2.9             .                1
                  533      96       081276        3.1             .                1
                  534      96       081676        3.1             .                1
                  535      96       081976        2.9             .                2
                  536      96       082376        2.7             .                1
                  537      96       082676        2.8             .                1
                  538      96       083076        2.6             .                1
                  539      96       090276        2.6             .                2
                  540      96       090676        1.7             .                1
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                              LISTING OF PMP DATA BY POLLUTANT                                              11
------------------------------------------------ POLL=BOD ------------------------------------------------------------
            OBS    PLANT     DATE      FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

            541      96     090976       2.50             .                1
            542      96     091376       2.20             .                2
            543      96     091676       2.60             .                2
            544      96     092076       2.50             .                1
            545      96     092376       2.20             .                1
            546      96     092776       2.60             .                1
            547     111     010477       0.83            55               12
            548     111     010577       0.96            65               11
            549     111     010677       0.93            80                6
            550     111     011177       0.91           105               10
            551     111     011277       0.83            90               10
            552     111     011377       0.70            87               12
            553     111     011877       0.78            65               10
            554     111     011977       0.98            80                9
            555     111     012077       0.65           100                6
            556     111     012577       0.84            79                8
            557     111     012677       0.99            76               13
            558     111     012777       0.98            75               13
            559     111     020177       0.63            80                7
            560     111     020277       0.61           100               12
            561     111     020377       0.73            90                6
            562     111     020877       0.87            80                6
            563     111     020977       0.99            85                5
            564     111     021077       0.96            88                6
            565     111     021577       0.92            65               10
            566     111     021677       0.69            65                8
            567     111     021777       1.00            60               20
            568     111     022277       0.74            95                8
            569     111     022377       1.14            90                6
            570     111     022477       1.08           100                5
            571     111     030177       0.74            80                8
            572     111     030277       0.68            90               10
            573     111     030377       0.43            80                5
            574     111     030877       0.73            88                9
            575     111     030977       0.57            83               10
            576     111     031077       1.15            75                8
            577     111     031577       1.37            50               10
            578     111     031677       1.01            75                8
            579     111     031777       1.18            84               12
            580     111     032277       1.11            75               18
            581     111     032377       1.06            68                8
            582     111     032477       0.96            65                8
            583     111     032977       0.98            70                8
            584     111     033077       0.80            80                6
            585     111     033177       0.95            80                6
            586     111     040477       0.93            95               12
            587     111     040577       1.15            70                6
            588     111     040677       0.74            80                5
            589     111     041277       0.92            53               10
            590     111     041377       1.10            60               10
            591     111     041477       0.87            55                8
            592     111     041977       0.45            60                8
            593     111     042077       0.94            70                8
            594     111     042177       1.02            64                8
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                              LISTING OF PMP DATA BY POLLUTANT                                       12
-------------------------------------------- POL'=BOD ----------------------------------------------

    OBS    PLANT    DATE     FLOW(MGD)   INFLUENT(PPM)   EFFLUENT(PPM)

    595     111    042677      0.83            68              8
    596     111    042777      0.96            77              6
    597     111    042877      0.55            75              6
    598     111    050377      0.77            68              6
    599     111    050477      0.65            65              8
    600     111    050577      0.81            64              6
    601     111    051077      0.82            95              8
    602     111    051177      0.72           100              8
    603     111    051277      0.75           100              8
    604     111    051777      0.93            58              8
    605     111    051877      0.93            60              6
    606     111    051977      0.87            60              7
    607     111    052477      0.98            36              7
    608     111    052577      1.07            32              7
    609     111    052677      1.17            32              6
    610     111    053177      1.03            32              5
    611     111    060177      0.85            40              6
    612     111    060277      1.17            45              7
    613     111    060777      1.09            32             15
    614     111    060877      1.08            40              8
    615     111    060977      0.77            38              8
    616     111    061477      0.85            37              5
    617     111    061577      0.82            40              4
    618     111    061677      0.84            50              6
    619     111    062177      0.42            32              5
    620     111    062277      0.92            24              4
    621     111    062377      1.01            32              4
    622     111    062877      1.01            73             14
    623     111    062977      0.62            75             10
    624     111    063077      0.87            90              8
    625     111    070577      0.66           160              4
    626     111    070677      0.74           120              4
    627     111    070777      0.67           115              4
    628     111    071277      0.82           130              4
    629     111    071377      0.99           118              5
    630     111    071477      1.01           125              4
    631     111    071977      0.88           140              5
    632     111    072077      0.65           120              4
    633     111    072177      0.97           100              4
    634     111    072677      0.74           110              8
    635     111    072777      0.96           100              4
    636     111    072877      0.93           100              5
    637     111    080277      1.08           110             16
    638     111    080377      1.09           117             14
    639     111    080477      1.09           118             12
    640     111    080977      1.03           102              4
    641     111    081077      0.93            88              4
    642     111    081177      0.92           110              4
    643     111    081677      0.99            75              2
    644     111    081777      0.87            88              3
    645     111    081877      1.16            80              3
    646     111    082377      0.75           116              4
    647     111    082477      0.74           120              3
    648     111    082577      0.94           125              4
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                          LISTING OF PMP DATA BY POLLUTANT

----------------------------------------- POLL=BOD ------------------------------------------

        OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

        649     111     083077      0.85            125               4
        650     111     083177      0.80            110               5
        651     111     090177      0.76            120               4
        652     111     090677      1.00            119               3
        653     111     090777      1.01             98               3
        654     111     090877      0.84             95               4
        655     111     091377      1.15            108               4
        656     111     091477      0.97            130               4
        657     111     091577      0.67            142               5
        658     111     092077      1.10            106               5
        659     111     092177      1.12             93               4
        660     111     092277      1.30             94               5
        661     111     092777      0.67             94               4
        662     111     092877      0.95            107               3
        663     111     092977      0.91            115               4
        664     111     100477      0.76            108               3
        665     111     100577      1.02            110               3
        666     111     100677      0.88            109               3
        667     111     101177      0.76            115               3
        668     111     101277      0.86            111               3
        669     111     101377      1.04            110               2
        670     111     101877      1.10             92               3
        671     111     101977      0.58            104               3
        672     111     102077      0.85            113               3
        673     111     102577      0.86            119               4
        674     111     102677      0.92            120               3
        675     111     102777      0.72            145               3
        676     111     110177      0.81            138               3
        677     111     110277      0.93            124               3
        678     111     110377      1.18            123               4
        679     111     110877      0.87            100               3
        680     111     110977      1.01            100               3
        681     111     111077      1.02            110               3
        682     111     111577      0.91            147               4
        683     111     111677      0.75            150               3
        684     111     111777      0.88            165               3
        685     111     112077      0.72            186               3
        686     111     112177      0.82            200               2
        687     111     112277      0.79            340               7
        688     111     112377      0.65            180              13
        689     111     112977      0.84            175               2
        690     111     113077      1.15            130               2
        691     111     120177      0.97            130               2
        692     111     120677      1.03            120               2
        693     111     120777      1.11            120               2
        694     111     120877      0.68            110               3
        695     111     121377      0.91            105               8
        696     111     121477      1.06             95               7
        697     111     121577      0.66             95               4
        698     111     121977      0.73            100               3
        699     111     122077      0.86            100               3
        700     111     122177      0.92             95               3
        701     111     122777      0.79            130               4
        702     111     122877      0.71            128               3
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                                LISTING OF PMP DATA BY POLLUTANT
----------------------------------------------------- POLL=BOD --------------------------------------------------------

                  OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                  703     111    122977      0.86            127              3.0
                  704     126    100275      0.38           1500              6.8
                  705     126    100575      0.28            640              4.4
                  706     126    100675      0.33            670              4.5
                  707     126    100775      0.30            460              6.2
                  708     126    100875      0.30           1500              6.2
                  709     126    100975      0.34           1800              6.9
                  710     126    101275      0.32           1300              4.7
                  711     126    101375      0.36           1100              5.1
                  712     126    101475      0.38           1100              4.4
                  713     126    101575      0.43           1100              4.4
                  714     126    101675      0.49           1200              4.7
                  715     126    101975      0.38            460              3.1
                  716     126    102075      0.32            330              4.8
                  717     126    102175      0.33            500              3.9
                  718     126    102275      0.31           1100              5.9
                  719     126    102375      0.32           1000              3.5
                  720     126    102675      0.30           1200              6.2
                  721     126    102775      0.44           1300              4.4
                  722     126    102875      0.53           1300              4.0
                  723     126    102975      0.41            910              4.4
                  724     126    103075      0.36           1100              3.9
                  725     126    110275      0.29            530              2.2
                  726     126    110375      0.30            540              2.5
                  727     126    110475      0.33            430              2.1
                  728     126    110575      0.37           1500              2.4
                  729     126    110675      0.39           1500              2.6
                  730     126    110975      0.44           1400              4.1
                  731     126    111075      0.58           1500              3.1
                  732     126    111175      0.48           1500              2.4
                  733     126    111275      0.45           1500              2.4
                  734     126    111375      0.49           1000              3.4
                  735     126    111675      0.41           1200              3.3
                  736     126    111775      0.43            660              1.7
                  737     126    111875      0.44           1100              2.5
                  738     126    111975      0.46           1100              1.8
                  739     126    112075      0.46           1500              1.6
                  740     126    112375      0.36            910              1.7
                  741     126    112475      0.38           1000              2.3
                  742     126    112575      0.41            370              2.4
                  743     126    112775      0.40            300              1.6
                  744     126    113075      0.35            570              2.0
                  745     126    120175      0.38            910              0.9
                  746     126    120275      0.33            900              1.7
                  747     126    120375      0.33            690              1.1
                  748     126    120475      0.40            490              2.6
                  749     126    120775      0.38            410              0.6
                  750     126    120875      0.35            760              1.1
                  751     126    120975      0.40            500              2.4
                  752     126    121075      0.30            570              1.5
                  753     126    121175      0.26            360              1.5
                  754     126    121475      0.39            520              2.0
                  755     126    121575      0.38            670              3.0
                  756     126    121675      0.35            750              1.4
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------------------------------------------------ POLT=BOD -----------------------------------------------------------

      OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

      757     126     121775      0.33            720              2.9
      758     126     121875      0.36            490              3.2
      759     126     122175      0.25            560              2.0
      760     126     122275      0.31            370              2.7
      761     126     122375      0.34            410              2.1
      762     126     122575      0.43            370              5.7
      763     126     122875      0.45            700              1.7
      764     126     122975      0.45            330              1.1
      765     126     123075      0.42            720              1.8
      766     126     010176      0.29            720              3.7
      767     126     010476      0.45            520             13.0
      768     126     010576      0.42            400              5.3
      769     126     010676      0.43            430              3.5
      770     126     010776      0.32            370              4.4
      771     126     010876      0.35            770              4.1
      772     126     011176      0.39           1700              3.2
      773     126     011276      0.40            830              3.2
      774     126     011376      0.37           1000              3.8
      775     126     011476      0.35           1500              1.8
      776     126     011576      0.32           1700              2.0
      777     126     011876      0.30            430              2.1
      778     126     011976      0.34            660              5.5
      779     126     012076      0.35            440              2.1
      780     126     012176      0.36           1000              2.5
      781     126     012276      0.33            660              1.3
      782     126     012576      0.39            370              2.0
      783     126     012676      0.35            970              3.3
      784     126     012776      0.35           1300              1.6
      785     126     012876      0.36           1200              9.9
      786     126     012976      0.44           1500              4.4
      787     126     020176      0.45           1700              5.0
      788     126     020276      0.34           2100              4.0
      789     126     020376      0.37            890              4.2
      790     126     020476      0.38           2000              4.5
      791     126     020576      0.41            500              7.2
      792     126     020876      0.46            800              4.3
      793     126     020976      0.42            630              3.3
      794     126     021076      0.35           1700              4.4
      795     126     021176      0.37           1200              3.9
      796     126     021276      0.34            930              4.3
      797     126     021676      0.35           1900              5.9
      798     126     021776      0.34           2400              4.6
      799     126     021876      0.36           1400              4.7
      800     126     021976      0.41           1100              4.7
      801     126     022276      0.27           1000              4.3
      802     126     022376      0.31            430              4.0
      803     126     022476      0.33            540              4.0
      804     126     022576      0.21            540              3.3
      805     126     022676      0.30            560              3.9
      806     126     022976      0.29            760              3.7
      807     126     030176      0.25            310              3.6
      808     126     030276      0.31            420              7.6
      809     126     030376      0.33            430              5.4
      810     126     030476      0.29            470              5.6
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                              LISTING OF PMP DATA BY POLLUTANT
------------------------------------------------ POLL=BOD ------------------------------------------------

                    OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                    811     126     030776      0.23             820              6.9
                    812     126     030876      0.38             820              7.2
                    813     126     030976      0.45             820              8.0
                    814     126     031076      0.37            1500              7.7
                    815     126     031176      0.39            1300              7.5
                    816     126     031476      0.24            1400             12.0
                    817     126     031576      0.33            1800             10.0
                    818     125     031676      0.40            1100             12.0
                    819     126     031776      0.35             930              9.2
                    820     126     031876      0.23            1600              9.2
                    821     126     032176      0.26            2200             19.0
                    822     126     032276      0.25             630             18.0
                    823     126     032376      0.26            1500             11.0
                    824     126     032476      0.27            1300             12.0
                    825     126     032576      0.27            1300             14.0
                    826     126     032876      0.26             490             13.0
                    827     126     032976      0.32             660             11.0
                    828     126     033076      0.39            1600             13.0
                    829     126     033176      0.51            1154             19.0
                    830     126     040176      0.44            1500             16.0
                    831     126     040476      0.38            1800             15.0
                    832     126     040576      0.30            1800             20.0
                    833     126     040676      0.23            2000             18.0
                    834     126     040776      0.26            2600             15.0
                    835     126     040876      0.25            2500             14.0
                    836     126     041176      0.23            1600             11.0
                    837     126     041276      0.23            1000              8.4
                    838     126     041376      0.26            1500             14.0
                    839     126     041476      0.27             600              7.8
                    840     126     041876      0.28             640             11.0
                    841     126     041976      0.33             660             13.0
                    842     126     042076      0.36             840             12.0
                    843     126     042176      0.33            1100             12.0
                    844     126     042276      0.33            1800             12.0
                    845     126     042576      0.31             820              5.4
                    846     126     042676      0.33             930              6.6
                    847     126     042776      0.28             730              5.7
                    848     126     042876      0.29            1200              7.5
                    849     126     050576      0.30            2300             18.0
                    850     126     050676      0.40            1900             15.0
                    851     126     050976      0.33            1300             11.0
                    852     126     051076      0.37            1300             12.0
                    853     126     051176      0.39            1300              9.1
                    854     126     051276      0.32            1100              8.5
                    855     126     051376      0.43             930              6.9
                    856     126     051676      0.19            1200              6.6
                    857     126     051776      0.36             560              6.3
                    858     126     051876      0.35            1700              4.6
                    859     126     051976      0.34            2100              8.1
                    860     126     052076      0.34            2600              7.7
                    861     126     052376      0.25            2000             10.0
                    862     126     052476      0.20            1600              8.7
                    863     126     052576      0.22            1600             10.0
                    864     126     052676      0.20            1100              8.3
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LISTING OF PMP DATA BY POLLUTANT

POLL=BOD

OBS	PLANT	DATE	FLOW(MGD)	INFLUENT(PPM)	EFFLUENT(PPM)
865	126	052776	0.28	2100	4.6
866	126	053176	0.20	1000	8.0
867	126	060176	0.25	640	9.9
868	126	060276	0.41	840	8.3
869	126	060376	0.27	850	7.7
870	126	060676	0.23	540	9.2
871	126	060776	0.23	1100	12.0
872	126	060876	0.23	600	12.0
873	126	060976	0.24	530	11.0
874	126	061076	0.27	1200	13.0
875	126	061376	0.27	1600	6.9
876	126	061476	0.41	1800	5.6
877	126	061576	0.28	1000	9.3
878	126	061676	0.38	400	5.3
879	126	061776	0.45	540	6.9
880	126	062076	0.37	1600	6.2
881	126	062176	0.42	2100	10.0
882	126	062276	0.50	1500	5.9
883	126	062376	0.43	1800	4.5
884	126	062476	0.37	1300	3.5
885	126	062776	0.33	910	4.2
886	126	062876	0.37	1500	8.3
887	126	062976	0.39	950	6.3
888	126	063076	0.35	1400	5.0
889	126	070176	0.27	1000	6.8
890	126	070576	0.28	1200	2.4
891	126	070676	0.30	1800	8.3
892	126	070776	0.42	2200	4.4
893	126	070876	0.38	1100	4.3
894	126	071176	0.27	1800	12.0
895	126	071276	0.29	2300	14.0
896	126	071376	0.25	1900	10.0
897	126	071476	0.30	1100	6.0
898	126	071576	0.37	1300	8.0
899	126	071876	0.29	.	5.9
900	126	071976	0.28	1000	4.1
901	126	072076	0.28	600	6.0
902	126	072176	0.28	2000	5.0
903	126	072276	0.37	1400	5.1
904	126	072576	0.34	.	2.8
905	126	072676	0.41	2300	8.4
906	126	072776	0.46	2400	5.4
907	126	072876	0.38	2200	8.4
908	126	072976	0.72	730	11.0
909	126	080176	0.41	1000	8.7
910	126	080276	0.33	950	5.3
911	126	080376	0.35	930	5.1
912	126	080476	0.33	1300	6.3
913	126	080576	0.37	1300	5.3
914	126	080876	0.33	700	5.1
915	126	080976	0.31	890	5.9
916	126	081076	0.28	820	4.1
917	126	081176	0.28	640	2.4
918	126	081276	0.36	530	4.2

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                          LISTING OF PMP DATA BY POLLUTANT                                      18

------------------------------------------------ POLL=BOD -----------------------------------------------------

            OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

            919     126    081576      0.40           530              5.1
            920     126    081676      0.43           710              3.6
            921     126    081776      0.35          2000              7.4
            922     126    081876      0.33          2000             11.0
            923     126    081976      0.31          1500              8.0
            924     126    082276      0.21           540              6.9
            925     126    082376      0.24           870              4.8
            926     126    082476      0.25           980              3.8
            927     126    082576      0.29          1200              6.3
            928     126    082676      0.37           980             12.0
            929     126    082976      0.28           640              2.0
            930     126    083076      0.32           670              1.9
            931     126    083176      0.38           930              2.8
            932     126    090176      0.42          1400              3.8
            933     126    090276      0.54          1300              2.6
            934     126    090676      0.33          1400              2.3
            935     126    090776      0.46           400              2.7
            936     126    090876      0.38           870              2.7
            937     126    090976      0.30           670              4.2
            938     126    091276      0.43          1100              3.0
            939     126    091376      0.52           840              4.2
            940     126    091476      0.55           570              2.1
            941     126    091576      0.63           640              3.1
            942     126    091676      0.45           440              3.3
            943     126    091976      0.34           530              2.0
            944     126    092076      0.47           610              3.2
            945     126    092176      0.53          1800              2.0
            946     126    092276      0.52           890              2.0
            947     126    092376      0.47          1500              2.1
            948     126    092676      0.45           870              2.3
            949     126    092776      0.53           930              1.8
            950     126    092876      0.49          1100              1.2
            951     126    092976      0.38           630              1.1
            952     126    093076      0.47           980              1.5

------------------------------------------------ POLL=OAG -----------------------------------------------------

            OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

            953      3     010377      0.19             .             27.0
            954      3     011077      0.20           52.0              .
            955      3     011677      0.19           86.5              .
            956      3     012477      0.17           62.0              .
            957      3     013177      0.16           46.0              .
            958      3     020777      0.19           82.0              .
            959      3     021477      0.16           52.0             12.0
            960      3     022177      0.20           39.0              .
            961      3     022877      0.20           31.0              .
            962      3     030777      0.21           62.0              .
            963      3     031477      0.18           62.0              .
            964      3     031777      0.20             .             22.0
            965      3     032177      0.24           44.0              .
            966      3     032877      0.22           38.0              .
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LISTING OF PMP DATA BY POLLUTANT

POLL=OAG

OBS	PLANT	DATE	FLOW(MGD)	INFLUENT(PPM)	EFFLUENT(PPM)
967	3	040477	0.23	119.0	.
968	3	041177	0.20	83.0	.
969	3	041477	0.22	.	17.5
970	3	041877	0.21	46.0	.
971	3	042577	0.22	44.0	.
972	3	050277	0.26	43.0	12.0
973	3	050977	0.21	61.0	.
974	3	051677	0.27	27.0	.
975	3	052377	0.26	35.0	.
976	3	060677	0.26	56.0	27.5
977	3	061377	0.29	52.0	.
978	3	062077	0.26	35.0	.
979	3	062777	0.25	23.0	.
980	3	070477	0.30	44.0	.
981	3	071177	0.31	31.0	.
982	3	071877	0.26	29.0	.
983	3	072577	0.29	24.0	16.0
984	3	080877	0.27	41.0	7.0
985	3	081577	0.25	37.0	.
986	3	082277	0.32	16.0	.
987	3	082977	0.27	27.0	.
988	3	090577	0.27	30.0	22.0
989	3	091277	0.26	38.0	.
990	3	091977	0.28	75.0	.
991	3	092677	0.26	61.0	.
992	3	101077	0.26	31.0	.
993	3	102477	0.32	41.0	22.0
994	3	103177	0.33	24.0	.
995	3	110777	0.26	21.0	.
996	3	111477	0.27	30.5	.
997	3	111577	0.29	.	12.5
998	3	112177	0.26	27.0	.
999	3	112877	0.26	37.0	.
1000	3	120577	0.28	36.5	12.5
1001	3	121277	0.28	31.0	.
1002	3	121977	0.29	46.5	.
1003	3	122777	0.29	32.5	.
1004	3	010978	0.28	25.0	.
1005	3	011678	0.31	10.5	8.5
1006	3	012378	0.34	12.0	.
1007	3	013078	0.23	36.0	.
1008	3	020678	0.24	16.0	13.0
1009	3	021378	0.25	19.0	.
1010	3	022778	0.24	26.0	.
1011	3	030678	0.26	225.0	.
1012	3	030778	0.26	.	26.0
1013	3	031378	0.26	188.0	.
1014	3	032078	0.26	56.0	3.3
1015	3	032178	0.25	.	11.0
1016	3	032778	0.26	42.0	.
1017	3	040378	0.32	41.0	.
1018	3	041078	0.34	36.5	.
1019	3	041778	0.26	38.0	.
1020	3	042478	0.25	36.0	11.0

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                                          LISTING OF PMP DATA BY POLLUTANT                                                        20
-------------------------------------------------------------- POLL=OAG --------------------------------------------------------------
                    OBS     PLANT     DATE     FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

                    1021      3      050178      0.25             56.5               .
                    1022      3      050278      0.25               .              31.0
                    1023      3      050878      0.24             32.0               .
                    1024      3      051578      0.23              8.0               .
                    1025      3      052278      0.22              6.0               .
                    1026      3      062678      0.25            312.0               .
                    1027      3      062778      0.24               .              16.5
                    1028      3      070378      0.27            133.0               .
                    1029      3      071078      0.29             67.5               .
                    1030      3      071178      0.27               .              20.5
                    1031      3      071778      0.26             78.5               .
                    1032      3      073178      0.27             85.0               .
                    1033      3      080778      0.27             65.9               .
                    1034      3      080978      0.30               .              22.5
                    1035      3      031478      0.33             77.5               .
                    1036      3      082178      0.30            100.5               .
                    1037      3      082878      0.29             93.0               .
                    1038      3      090478      0.27            230.0               .
                    1039      3      091178      0.33             16.0               .
                    1040      3      091278      0.29               .              10.0
                    1041      3      091878      0.28             47.0               .
                    1042      3      092578      0.29             99.0               .
                    1043      3      100278      0.30             99.5               .
                    1044      3      100978      0.27             61.5               .
                    1045      3      101678      0.28             55.0              12.0
                    1046      3      102378      0.28             57.5               .
                    1047      3      103078      0.29              9.9               .
                    1048      3      110678      0.30             48.0               .
                    1049      3      111378      0.31             10.1               .
                    1050      3      111578      0.32               .               3.0
                    1051      3      112078      0.33             12.5               .
                    1052      3      112778      0.32             15.0               .
                    1053      3      120478      0.32              7.5               5.0
                    1054      3      121178      0.27              9.1               .
                    1055      3      121878      0.30              8.7               .
                    1056      3      122578      0.30             11.9               .
                    1057      3      010879      0.27              9.2               8.8
                    1058      3      011579      0.29             16.0               .
                    1059      3      012279      0.31             17.1               .
                    1060      3      012979      0.29             15.3               .
                    1061      3      020579      0.38             17.2               .
                    1062      3      021279      0.28             24.4               .
                    1063      3      021979      0.30             10.5               .
                    1064      3      022779      0.31             11.7               4.2
                    1065      3      030579      0.32             37.9               .
                    1066      3      031279      0.31             22.0               .
                    1067      3      031979      0.33             21.8               .
                    1068      3      032879      0.32               .              18.6
                    1069      3      032979      0.32               .              26.1
                    1070      3      033079      0.30             26.1               .
                    1071      3      040279      0.36             27.8               .
                    1072      3      040979      0.37             34.0               .
                    1073      3      041679      0.27             46.0               .
                    1074      3      042479      0.30             30.0              14.7
```

LISTING OF [illegible] DATA BY POLLUTANT

POLL=OAG

OBS	PLANT	DATE	FLOW(MGD)	INFLUENT(PPM)	EFFLUENT(PPM)
1075	3	050779	[illegible]	39.6	.
1076	3	051479	0.33	38.2	.
1077	3	052179	0.31	37.0	24.5
1078	3	052879	0.31	30.9	.
1079	3	060479	0.34	28.9	12.9
1080	3	061179	0.31	35.6	.
1081	3	061879	0.34	13.5	.
1082	3	062579	0.34	32.6	.
1083	3	070279	0.35	38.2	.
1084	3	070979	0.30	2.3	1.7
1085	3	071779	0.36	14.2	.
1086	3	073079	0.33	25.9	.
1087	3	080679	0.36	29.0	21.0
1088	3	081379	0.39	28.6	.
1089	3	081679	0.34	.	6.7
1090	3	082079	0.30	25.6	.
1091	3	082779	0.35	26.0	.
1092	3	090379	0.31	23.8	.
1093	3	091079	0.38	28.3	.
1094	3	091779	0.38	19.0	.
1095	3	092479	0.36	9.9	1.4
1096	3	100179	.	23.0	.
1097	3	100879	0.31	6.2	.
1098	3	100979	0.36	.	2.3
1099	3	102279	0.30	4.3	.
1100	3	102979	0.32	11.0	.
1101	3	110579	0.31	17.0	.
1102	3	110679	0.30	.	3.7
1103	3	111979	0.32	32.9	.
1104	3	112679	0.33	28.1	.
1105	3	120379	0.30	5.7	1.4
1106	3	121079	0.29	22.4	.
1107	3	121779	0.23	38.2	.
1108	3	011060	0.34	20.6	17.3
1109	3	011180	0.34	.	21.9
1110	3	011480	0.35	32.4	.
1111	3	012180	0.29	28.6	.
1112	3	012880	0.28	33.1	.
1113	3	020480	0.33	46.9	.
1114	3	021280	0.29	82.8	.
1115	3	021380	0.30	.	1.3
1116	3	021980	0.26	58.5	.
1117	3	022580	0.28	37.3	.
1118	3	030380	0.28	37.3	.
1119	3	031080	0.32	24.0	.
1120	3	031280	0.34	3.6	.
1121	3	031780	0.35	.	0.4
1122	3	032480	0.30	24.5	.
1123	3	033180	0.35	34.7	.
1124	3	040780	0.30	18.8	.
1125	3	041480	0.36	13.9	.
1126	3	041580	0.32	.	5.0
1127	3	042880	0.32	27.6	.
1128	3	050580	0.28	11.3	.

```
                                  LISTING OF FMP DATA BY POLLUTANT

---------------------------------------------------------- POLL=OAG -----------------------------------------------------------

                      OBS     PLANT     DATE      FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

                      1129      3      051280       0.29           11.1                 .
                      1130      3      051380       0.30             .                  2
                      1131      3      051980       0.28           16.9                 .
                      1132     61      010375        .               .                 28
                      1133     61      010675        .               .                 18
                      1134     61      010875        .               .                 16
                      1135     61      011575        .               .                 26
                      1136     61      012075        .               .                 49
                      1137     61      012275        .               .                 50
                      1138     61      012975        .               .                 18
                      1139     61      020375        .               .                130
                      1140     61      020575        .               .                 21
                      1141     61      021075        .               .                 21
                      1142     61      021275        .               .                 30
                      1143     61      021775        .               .                 24
                      1144     61      021975        .               .                 31
                      1145     61      022475        .               .                 46
                      1146     61      022675        .               .                 19
                      1147     61      030375        .               .                  4
                      1148     61      030575        .               .                  6
                      1149     61      031075        .               .                  6
                      1150     61      031275        .               .                  7
                      1151     61      031775        .               .                 11
                      1152     61      031975        .               .                 76
                      1153     61      032475        .               .                  7
                      1154     61      032675        .               .                 14
                      1155     61      040175        .               .                 11
                      1156     61      040275        .               .                  7
                      1157     61      040375        .               .                  9
                      1158     61      040475        .               .                 10
                      1159     61      040775        .               .                 20
                      1160     61      040875        .               .                 19
                      1161     61      040975        .               .                 11
                      1162     61      041075        .               .                 22
                      1163     61      041175        .               .                 11
                      1164     61      041475        .               .                 31
                      1165     61      041575        .               .                 42
                      1166     61      041675        .               .                 18
                      1167     61      041775        .               .                 23
                      1168     61      041875        .               .                  5
                      1169     61      042175        .               .                 10
                      1170     61      042275        .               .                 13
                      1171     61      042375        .               .                 12
                      1172     61      042475        .               .                 19
                      1173     61      042575        .               .                  5
                      1174     61      042875        .               .                 29
                      1175     61      042975        .               .                 16
                      1176     61      043075        .               .                 38
                      1177     61      050175        .               .                 13
                      1178     61      050275        .               .                  6
                      1179     61      050575        .               .                 11
                      1180     61      050675        .               .                 13
                      1181     61      050775        .               .                 14
                      1182     61      050875        .               .                 10
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                                   LISTING OF PMP DATA BY POLLUTANT                                                      23
------------------------------------------------------- POLL=OAG ----------------------------------------------------------
                      OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                      1183    61     050975        .              .                3
                      1184    61     051275        .              .                9
                      1185    61     051375        .              .               13
                      1186    61     051475        .              .               24
                      1187    61     051575        .              .               11
                      1188    61     051675        .              .               13
                      1189    61     051975        .              .                9
                      1190    61     052075        .              .               17
                      1191    61     052175        .              .               36
                      1192    61     052275        .              .               14
                      1193    61     052375        .              .               16
                      1194    61     052675        .              .               75
                      1195    61     052775        .              .               19
                      1196    61     052875        .              .              265
                      1197    61     052975        .              .               13
                      1198    61     053075        .              .               14
                      1199    61     060275        .              .               15
                      1200    61     060375        .              .               13
                      1201    61     060975        .              .                9
                      1202    61     061675        .              .                6
                      1203    61     061875        .              .               13
                      1204    61     062075        .              .                3
                      1205    61     062475        .              .               17
                      1206    61     062675        .              .               10
                      1207    61     062775        .              .               16
                      1208    61     070175        .              .               14
                      1209    61     070275        .              .               12
                      1210    61     070375        .              .               11
                      1211    61     070475        .              .               15
                      1212    61     070875        .              .                8
                      1213    61     071075        .              .               13
                      1214    61     071175        .              .                5
                      1215    61     071575        .              .                5
                      1216    61     071675        .              .                4
                      1217    61     071775        .              .                5
                      1218    61     071875        .              .               11
                      1219    61     072275        .              .               15
                      1220    61     072475        .              .               14
                      1221    61     072575        .              .               14
                      1222    61     072875        .              .               12
                      1223    61     072975        .              .               25
                      1224    61     073075        .              .               10
                      1225    61     080675        .              .                6
                      1226    61     080775        .              .               11
                      1227    51     080875        .              .               12
                      1228    61     081175        .              .               13
                      1229    61     081275        .              .                8
                      1230    61     081375        .              .               17
                      1231    61     081475        .              .               11
                      1232    61     081575        .              .               20
                      1233    61     081875        .              .               29
                      1234    61     081975        .              .               10
                      1235    61     082075        .              .               11
                      1236    61     082175        .              .               10
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                                   LISTING OF PMP DATA BY POLLUTANT                                         24

------------------------------------------------------------ POLL=OAG ------------------------------------------------------------

            OBS     PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

            1237     61      082275        .              .               55
            1238     61      082575        .              .                9
            1239     61      082675        .              .                6
            1240     61      082775        .              .               14
            1241     61      082875        .              .                7
            1242     61      082975        .              .                6
            1243     61      090175      2.73             9                6
            1244     61      090275      2.73             9                7
            1245     61      090375      2.73            26                8
            1246     61      090475      2.73            12               10
            1247     61      090575      2.73            17                8
            1248     61      090875      2.73            21               13
            1249     61      090975      2.59             .               13
            1250     61      091075      2.73            28               12
            1251     61      091175      2.59            13               11
            1252     61      091275      2.59            12                .
            1253     61      091575      2.88             6                .
            1254     61      091775      2.88            12                .
            1255     61      091875      2.88             8               12
            1256     61      091975      2.88             8                8
            1257     61      092275      2.88             7               11
            1258     61      092375      2.88             8               14
            1259     61      092475      2.88            12                7
            1260     61      092575      3.60             7                5
            1261     61      092975      1.58             .               17
            1262     61      093075      1.87            10                9
            1263     61      100275      2.01            12                8
            1264     61      100375      2.01            58                .
            1265     61      100675      1.65            16                8
            1266     61      100775      1.64            22                7
            1267     61      100875      1.64            14               10
            1268     61      100975      1.65            12                8
            1269     61      101075      1.72            13               14
            1270     61      101375      2.16            17               11
            1271     61      101475      2.59            23                6
            1272     61      101575      2.59            24               12
            1273     61      101675      2.59            11               17
            1274     61      101775      2.59             8                7
            1275     61      102075      2.01            14                6
            1276     61      102175      2.01            11                5
            1277     61      102375      1.44            11                7
            1278     61      102475      1.87             7                .
            1279     61      102775      2.59            35               20
            1280     61      102875      2.59             7                6
            1281     61      102975      2.59             9                5
            1282     61      103075      2.59            13                7
            1283     61      103175      2.59             8                7
            1284     61      110375      2.59            10               12
            1285     61      110475      2.59             5                5
            1286     61      110575      2.59            21                6
            1287     61      110675      2.44            14                6
            1288     61      110775      2.44             7                3
            1289     61      111175      2.44            19                5
            1290     61      111275      2.44            14                9
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                                  LISTING OF PMP DATA BY POLLUTANT
-------------------------------------------------- POLL=OAG --------------------------------------------------
      OBS    PLANT    DATE    FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

     1291     61     111375     2.44             .                8
     1292     61     111475     2.41             6                .
     1293     61     111775     2.44             9                3
     1294     61     111875     2.44             6                4
     1295     61     111975     2.52            63                4
     1296     61     112075     2.59             2                5
     1297     61     112175     2.59             3                4
     1298     61     112475     2.16             4                9
     1299     61     112575     2.30            15                9
     1300     61     112675     2.59            13                4
     1301     61     120275     2.52            12                .
     1302     61     120375     2.59             9                7
     1303     61     120475     2.44             .                8
     1304     61     120575     2.30             .               64
     1305     61     120875      .               7                9
     1306     61     120975     2.66             8                8
     1307     61     121075     2.73             4                5
     1308     61     121175     2.66             6                6
     1309     61     121275     2.59             8                6
     1310     61     121575     2.59             9                6
     1311     61     121675     2.73             8                6
     1312     61     121775     2.30             9                7
     1313     61     121975     2.73             9                5
     1314     61     122275     2.73             9                8
     1315     61     122975     2.73             8                8
     1316     61     123075     2.73             6                8
     1317     61     123175     2.73            15               11
     1318     61     010276     2.91             7               10
     1319     61     010576     2.88            15               18
     1320     61     010676     2.73             9                8
     1321     61     010776     2.88             9                9
     1322     61     010876     2.88             .               10
     1323     61     011276     2.89            11               14
     1324     61     011376     2.88            19                8
     1325     61     011576     2.95             6                9
     1326     61     011676     2.80             7                3
     1327     61     011976     2.08             8                5
     1328     61     012076     2.08             3                4
     1329     61     012176     2.37             8                8
     1330     61     012276     2.66            10                7
     1331     61     012376     2.66             7                7
     1332     61     013076     3.09             .                9
     1333     61     020376     2.80             5                5
     1334     61     020476     2.30             6                9
     1335     61     020576     2.01             8                8
     1336     61     020676     2.44             5                .
     1337     61     020976     2.59            12                9
     1338     61     021176     2.30             7                6
     1339     61     021376     2.03             9               14
     1340     61     021675     2.16             .               13
     1341     61     021776     2.16             9                9
     1342     61     021876     2.01            20               10
     1343     61     022376     2.44             7               16
     1344     61     022476     2.37             9               10
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------------------------------------------------------------- POLL=OAG -------------------------------------------------------------

      OBS     PLANT     DATE      FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

      1345     61      022576       2.23             .                 7
      1346     61      022776       2.23             9                 6
      1347     61      030176       1.58            10                 9
      1348     61      030276       1.58             8                 6
      1349     61      030476       1.58             8                10
      1350     61      030576       1.58             .                10
      1351     61      030876       2.03             6                 4
      1352     61      030976       2.30            11                 7
      1353     61      031076       2.44             5                 8
      1354     61      031176       2.44             8                 2
      1355     61      031276       2.44            10                 7
      1356     61      031576       2.73             6                 8
      1357     61      031776       2.16            14                 6
      1358     61      031876       1.72            14                11
      1359     61      031976       1.58             7                12
      1360     61      032276       2.01            19                 3
      1361     61      032376       2.30            17                 8
      1362     61      032476       2.37            20                 8
      1363     61      032576       2.52            13                 6
      1364     61      032676       2.59            10                 6
      1365     61      032976       2.59             8                 9
      1366     61      033076       2.59            13                10
      1367     61      033176       2.59            10                 8
      1368     61      040176       2.59             8                12
      1369     61      040576       2.30            12                 9
      1370     61      040676       2.30            12                 8
      1371     61      040776       2.30             8                 6
      1372     61      040876       2.30            11                 7
      1373     61      041176       2.30             8                 8
      1374     61      041276       2.30            20                 3
      1375     61      041376       2.01            22                 7
      1376     61      041476       2.01            16                10
      1377     61      041875       1.87             9                12
      1378     61      041976       1.87            14                 7
      1379     61      042076       1.87            17                 8
      1380     61      042276       2.47            18                10
      1381     61      042576       2.30             .                 8
      1382     61      042676       2.30            18                13
      1383     61      042776       2.44            26                 9
      1384     61      042876       2.52            27                 7
      1385     61      042976       2.12            17                15
      1386     61      050276       2.13            31                 9
      1387     61      050376       2.23            10                10
      1388     61      050476       2.30            12                 9
      1389     61      050576       2.30            21                11
      1390     61      050676       2.44             5                10
      1391     61      050976       2.88            28                11
      1392     61      051076       2.89             6                 1
      1393     61      051176       2.88             9                 4
      1394     61      051275       2.88            27                 5
      1395     61      051376       2.88             6                 2
      1396     61      051676       1.87            14                 6
      1397     61      051776       1.87            12                 5
      1398     61      051876       2.10            10                31
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                         LISTING OF FMP DATA BY POLLUTANT

-------------------------------------- POLL=OAG ----------------------------------------

          OBS     PLANT     DATE     FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

          1399     61      051976      2.10              9                 6
          1400     61      052076      1.97              9                 5
          1401     61      052376      1.72             11                 7
          1402     61      052476      1.58             10                 5
          1403     61      052576      1.58             11                 7
          1404     61      052676      2.16             11                 8
          1405     61      052776      2.05             10                 3
          1406     61      053076      1.80             12                 6
          1407     61      053176      2.26             20                 7
          1408     61      060176      2.79              7                 4
          1409     61      060276      2.88              7                 9
          1410     61      060376      2.88             17                21
          1411     61      060676      2.16             17                11
          1412     61      060776      2.37             20                18
          1413     61      060876      2.37             20                10
          1414     61      060976      2.37             20                13
          1415     61      061076      2.37             23                13
          1416     61      061376      1.88             46                41
          1417     61      061476      1.69             36                45
          1418     61      061576      2.14             16                31
          1419     61      061676      2.69             42                31
          1420     61      061776      2.88             44                41
          1421     61      062076      2.88             19                22
          1422     61      062176      2.88             20                11
          1423     61      062276      2.88             26                23
          1424     61      062376      2.88             22                19
          1425     61      062476      2.88             26                26
          1426     61      062776      2.88             22                20
          1427     61      062876      2.88             18                18
          1428     61      062976      2.88             19                17
          1429     61      063076      2.88             23                23
          1430     61      070176      2.88             19                27
          1431     61      070576      2.88             25                17
          1432     61      070676      2.88             31                29
          1433     61      071176      2.88             35                22
          1434     61      071276      2.80             39                33
          1435     61      071376      1.62             29                31
          1436     61      071476      2.01             22                29
          1437     61      071876      2.35             28                10
          1438     61      071976      2.86             28                16
          1439     61      072076      2.85             30                26
          1440     61      072176      2.88             30                29
          1441     61      072276      2.88             30                19
          1442     61      072576      2.88             33                29
          1443     61      072676      2.88             28                27
          1444     61      072776      2.24             17                14
          1445     61      072876      2.13             16                13
          1446     61      072976      2.59             19                16
          1447     61      073076      2.01              .                13
          1448     61      080176      2.01             14                13
          1449     61      080376      2.70             26                14
          1450     61      080476      2.56             31                 4
          1451     61      080576      2.44             31                16
          1452     61      080676      2.27             31                18
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                              LISTING OF PMP DATA BY POLLUTANT

-------------------------------------------------- POLL=OAG --------------------------------------------------

              OBS     PLANT     DATE     FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

              1453      61     080976       1.90             22               15.0
              1454      61     081076       1.65             34               17.0
              1455      61     081176       1.58             32               19.0
              1456      61     081276       1.69             27               15.0
              1457      61     081576       2.16             27               19.0
              1458      61     081676       2.16             25               19.0
              1459      61     081776       2.16             26               20.0
              1460      61     081876       2.26             33               22.0
              1461      61     081976       2.45             41               24.0
              1462      61     082276       2.10             31               17.0
              1463      61     082376       1.62             34               16.0
              1464      61     082476       2.16             25               15.0
              1465      61     082576       2.15             21               14.0
              1466      61     082676       2.16             22               21.0
              1467      61     082976       2.16             28               12.0
              1468      61     083076       2.16             30                 .
              1469      61     083176       2.23             23               14.0
              1470      61     090176       2.32             25               12.0
              1471      61     090276       2.62            230               18.0
              1472      61     090776       2.72             19               12.0
              1473      61     090876       2.70             30                 .
              1474      61     090976       2.70             30               24.0
              1475      61     091276       2.70             22               20.0
              1476      61     091376       2.70             28               25.0
              1477      61     091476       2.67             19               27.0
              1478      61     091576       2.66             25               24.0
              1479      61     091676       2.66             14               11.0
              1480      61     091976       2.72             16               13.0
              1481      61     092076       2.73              8               17.0
              1482      61     092176       2.73             12               10.0
              1483      61     092276       2.75             14               12.0
              1484      61     092376       2.80             13               18.0
              1485      61     092676       2.85             22               11.0
              1486      61     092776       2.85             13               15.0
              1487      61     092876       2.85             15                9.0
              1488      61     092976       2.85             23               15.0
              1489      61     093076       2.85              .               13.0
              1490     124     011475        .                .                1.3
              1491     124     012375       0.28              .                6.4
              1492     124     012875       0.20              .                1.5
              1493     124     013075       0.18              .                9.0
              1494     124     020475        .                .                1.5
              1495     124     020675        .                .                7.8
              1496     124     021175        .                .               13.3
              1497     124     021375        .                .                3.0
              1498     124     021475        .                .                3.0
              1499     124     031375        .                .                0.4
              1500     124     031875        .                .                0.8
              1501     124     032575        .                .                0.6
              1502     124     041175        .                8                 .
              1503     124     041375        .                .                2.6
              1504     124     041875        .                .                4.0
              1505     124     042075        .                .               11.9
              1506     124     042275        .                .               11.1
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------------------------------------------------------- POLL=OAG ----------------------------------------------------------

                  OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                  1507    124    042775        .              .              3.2
                  1508    124    042975        .              .             11.1
                  1509    124    050475        .              .              1.6
                  1510    124    051175        .              .              0.8
                  1511    124    051675        .              .              0.9
                  1512    124    051875        .              .              8.5
                  1513    124    052075        .              .              3.8
                  1514    124    052375        .              .              0.5
                  1515    124    052575        .              .              1.4
                  1516    124    052775        .              .              0.8
                  1517    124    060175        .              .              0.4
                  1518    124    060675        .             4.0              .
                  1519    124    061075        .              .              2.0
                  1520    124    062075        .              .              0.4
                  1521    124    062275        .              .              5.9
                  1522    124    062375        .              .              0.3
                  1523    124    062775        .              .              2.7
                  1524    124    062975        .              .              0.6
                  1525    124    070475        .              .              0.9
                  1526    124    070675        .              .              2.8
                  1527    124    070875        .              .              0.2
                  1528    124    071375        .              .              0.3
                  1529    124    071575        .              .              4.5
                  1530    124    072275        .              .              0.2
                  1531    124    072575        .              .              5.7
                  1532    124    072775        .              .              3.6
                  1533    124    072975        .              .              4.0
                  1534    124    080175        .              .             17.3
                  1535    124    080375        .              .              7.3
                  1536    124    080575        .              .             14.2
                  1537    124    080875        .             1.8             5.2
                  1538    124    081075        .              .             23.5
                  1539    124    081275        .              .             15.8
                  1540    124    081575        .              .              1.0
                  1541    124    081775        .              .             36.0
                  1542    124    081975        .              .              2.7
                  1543    124    082275        .            33.0            10.8
                  1544    124    082475        .            51.1             1.2
                  1545    124    082675        .              .             17.0
                  1546    124    082775        .            14.2              .
                  1547    124    082975        .              .             21.2
                  1548    124    083175        .              .             20.4
                  1549    124    090175        .            52.4              .
                  1550    124    090275        .              .              1.2
                  1551    124    090575        .            16.7             6.2
                  1552    124    090775        .              .             29.3
                  1553    124    090975        .              .             34.4
                  1554    124    091275        .              .              1.2
                  1555    124    091475        .              .              1.8
                  1556    124    091675        .              .              6.1
                  1557    124    091975        .              .              4.4
                  1558    124    092175        .              .              4.6
                  1559    124    092375        .              .              1.0
                  1560    124    092675        .              .              1.9
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--------------------------------------------------------- POLL=OAG ----------------------------------------------------------

                  OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

                  1561    124     092875       .               .              4.0
                  1562    124     093075       .               .              3.2
                  1563    124     100375       .               .              3.8
                  1564    124     100575       .               .              0.4
                  1565    124     101075       .             13.2              .
                  1566    124     101475       .             24.3              .
                  1567    124     102175       .             55.2              .
                  1568    124     102875       .             23.1             1.1
                  1569    124     110475       .             15.7             4.1
                  1570    124     111175       .              3.5             2.3
                  1571    124     111875       .             24.9              .
                  1572    124     112575       .             15.8             0.1
                  1573    124     120275       .             13.1             5.4
                  1574    124     120975       .             17.2              .
                  1575    124     121675       .             40.2             1.1
                  1576    124     122375       .             60.6              .
                  1577    124     123075       .             22.1             4.0
                  1578    124     010676       .             30.5             3.3
                  1579    124     011376       .             30.7             2.4
                  1580    124     012076       .              7.1              .
                  1581    124     012776       .              9.0             2.9
                  1582    124     020376     0.36             6.7             0.7
                  1583    124     021076     0.57             7.9              .
                  1584    124     021776     0.60            13.2              .
                  1585    124     022476     0.17            45.1             0.5
                  1586    124     030276     0.29            26.6             0.2
                  1587    124     030976     0.31            37.4             0.6
                  1588    124     031676     0.35            12.5             0.6
                  1589    124     032376     0.47            20.6             2.4
                  1590    124     033076     0.42            17.9             2.2
                  1591    124     040676     0.37             8.4             2.4
                  1592    124     041376     0.53            25.2              .
                  1593    124     042076     0.39            76.3              .
                  1594    124     042776       .            103.2             1.1
                  1595    124     050476     0.33            11.1             3.0
                  1596    124     051176     0.51            17.2             2.6
                  1597    124     051876     0.44            14.9             3.5
                  1598    124     052576     0.29            26.1              .
                  1599    124     060176     0.41            39.2              .
                  1600    124     060876     0.30             0.4              .
                  1601    124     061576     0.36             1.9              .
                  1602    124     062276       .             25.8              .
                  1603    124     062976     0.31            10.1              .
                  1604    124     070676       .             11.0              .
                  1605    124     071276     0.32            16.1              .
                  1606    124     071376     0.27              .              5.1
                  1607    124     072076     0.59            10.7             1.8
                  1608    124     072776     0.58            18.7             0.1
                  1609    124     080376     0.40            18.3              .
                  1610    124     081076     0.46             0.4              .
                  1611    124     082476     0.28            11.6              .
                  1612    124     082676     0.34              .             17.6
                  1613    124     082776       .               .              0.1
                  1614    124     083176     0.24            23.6
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LISTING OF PMP DATA BY POLLUTANT

POLL=OAG

OBS	PLANT	DATE	FLOW(MGD)	INFLUENT(PPM)	EFFLUENT(PPM)
1615	124	090776	0.29	46.4	2.4
1616	124	091476	0.81	17.3	.
1617	124	092176	0.46	23.6	0.7
1618	124	092876	0.66	18.4	.
1619	170	060478	3.58	48.6	2.2
1620	170	060778	4.18	62.4	15.6
1621	170	061178	2.47	28.6	3.6
1622	170	061478	3.17	55.8	9.6
1623	170	061878	3.42	50.8	2.4
1624	170	062178	3.02	81.8	6.6
1625	170	062578	3.66	134.6	2.0
1626	170	062978	3.49	42.2	8.0
1627	170	070478	3.82	35.8	6.0
1628	170	070578	3.16	61.0	3.0
1629	170	070978	3.02	52.0	9.0
1630	170	071278	2.66	64.0	3.0
1631	170	071678	3.17	12.0	3.0
1632	170	071978	3.06	52.0	6.0
1633	170	072378	3.15	24.0	8.8
1634	170	072678	3.14	71.0	2.4
1635	170	073078	2.86	34.0	5.4
1636	170	080278	2.99	159.8	17.8
1637	170	080678	2.74	50.0	4.6
1638	170	080978	2.74	64.2	7.2
1639	170	081378	2.96	33.0	4.0
1640	170	081678	2.59	29.0	9.0
1641	170	082078	2.66	167.0	7.0
1642	170	082378	2.98	32.0	4.0
1643	170	082778	2.66	76.6	3.8
1644	170	083078	3.58	53.6	0.6
1645	170	090378	2.51	102.6	2.4
1646	170	090678	2.64	91.0	9.0
1647	170	091078	3.02	104.2	5.6
1648	170	091378	3.64	58.8	14.6
1649	170	092078	2.64	34.0	8.0
1650	170	092178	2.88	28.0	7.0
1651	170	092478	2.75	72.0	11.0
1652	170	092778	2.62	65.4	7.2
1653	170	100178	2.62	107.0	20.0
1654	170	100478	2.83	26.0	6.0
1655	170	100878	3.05	84.0	17.0
1656	170	101178	2.66	168.0	5.0
1657	170	101578	2.86	95.0	8.0
1658	170	101878	3.35	20.0	5.0
1659	170	102278	2.76	115.0	19.0
1660	170	102578	2.90	31.0	5.0
1661	170	102978	3.19	27.0	1.0
1662	170	110178	2.33	71.0	13.0
1663	170	110578	2.33	19.2	2.0
1664	170	110678	2.33	127.0	20.0
1665	170	111278	2.62	31.6	12.4
1666	170	111578	2.98	147.2	11.6
1667	170	111978	2.40	21.0	6.0
1668	170	112278	2.04	143.0	7.4

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                             LISTING OF PMP DATA BY POLLUTANT

--------------------------------------------- POLL=OAG ---------------------------------------------

   OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

   1669    170    112678      2.50           38.0             13.0
   1670    170    112978      2.54           67.0             11.0
   1671    170    120378      2.86           75.6             10.2
   1672    170    120678      2.82           64.0              6.4
   1673    170    121078      3.32           85.1             10.0
   1674    170    121378      2.73           89.8             21.8
   1675    170    121778      3.01          104.0              9.0
   1676    170    122078      2.55           95.0              5.0
   1677    170    122478      2.45          180.0              6.0
   1678    170    122778      3.02           88.0              6.0
   1679    170    123178      3.29             .              11.0
   1680    170    010379      3.00          109.0             17.0
   1681    170    010779      3.00          176.0             10.0
   1682    170    011079      3.00          187.0             13.0
   1683    170    011479      3.00           43.0             10.0
   1684    170    011779      3.00           40.0              7.0
   1685    170    012179      3.20           52.0              4.0
   1686    170    012479      2.71          123.0             15.0
   1687    170    012879      2.72          109.0             28.0
   1688    170    013179      2.89           32.0              7.0
   1689    170    020479      3.13           65.0              8.0
   1690    170    020779      2.86           92.0              4.6
   1691    170    021179      2.72          140.0             12.0
   1692    170    021479      3.50           58.0             10.0
   1693    170    021879      2.32          276.0             12.0
   1694    170    022179      3.28          246.0               .
   1695    170    022579      3.43          110.0             25.0
   1696    170    022879      3.47           66.0             16.0
   1697    170    030479      2.60           43.0             13.0
   1698    170    030779      2.53           94.0             15.3
   1699    170    031179      1.76           54.0             18.0
   1700    170    031579      2.22           70.0             17.0
   1701    170    031879      2.32           94.0             26.0
   1702    170    032179      1.74           70.0             18.0
   1703    170    032579      3.05           95.0             29.0
   1704    170    032879      2.42          146.0             35.0
   1705    170    040179      3.12          116.0             14.0
   1706    170    040479      1.34           73.0             12.0
   1707    170    040879      2.04           62.0              6.0
   1708    170    041179      2.78           71.0              4.0
   1709    170    041579      2.54          326.0              8.0
   1710    170    041879      2.50          137.0              3.0
   1711    170    042279      2.50           56.0              5.0
   1712    170    042579      2.48           85.0              6.0
   1713    170    042979      2.27           40.0              8.0
   1714    170    050279      2.53          231.0             14.0
   1715    170    050679      2.08           80.0             20.0
   1716    170    050979      2.03           75.0             18.0
   1717    170    051379      3.48           51.8             23.0
   1718    170    051679      2.52           81.9              6.8
   1719    170    052079      2.66           71.0             11.0
   1720    170    052379      2.94           56.0              8.0
   1721    170    052779      2.63           70.0             12.0
   1722    170    053079      2.68           52.0              3.2
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--- POLL=OAG ---

OBS	PLANT	DATE	FLOW(MGD)	INFLUENT(PPM)	EFFLUENT(PPM)
1723	170	060379	2.74	78.6	17.8
1724	170	060679	2.21	39.0	17.0
1725	170	061079	2.96	163.0	24.0
1726	170	061379	2.30	409.0	39.0
1727	170	061779	3.90	202.0	28.0
1728	170	062079	2.99	56.4	3.2
1729	170	062479	2.90	106.0	8.0
1730	170	062779	2.57	200.0	10.6
1731	170	070179	3.22	56.0	19.6
1732	170	070479	3.64	46.0	11.0
1733	170	070879	1.97	56.0	9.0
1734	170	071179	2.90	54.0	16.0
1735	170	071579	2.51	49.0	2.0
1736	170	071879	3.36	61.0	10.0
1737	170	072279	3.00	42.0	13.0
1738	170	072579	3.01	82.0	11.0
1739	170	072979	3.32	42.0	12.0
1740	170	080179	3.32	139.8	21.2
1741	170	080579	2.90	86.4	5.4
1742	170	080879	2.30	98.0	5.2
1743	170	081279	2.83	58.2	14.6
1744	170	081579	2.57	20.8	2.8
1745	170	081979	3.70	40.0	7.0
1746	170	082279	3.44	56.0	16.0
1747	170	082679	2.78	95.0	18.0
1748	170	082979	3.71	55.0	17.8
1749	170	090279	3.19	47.2	6.2
1750	170	090579	3.19	28.6	5.8
1751	170	090979	3.05	56.8	18.6
1752	170	091279	3.10	50.2	10.6
1753	170	091679	3.05	79.4	8.8
1754	170	091979	3.05	111.0	10.2
1755	170	092379	3.57	95.6	11.2
1756	170	092679	2.64	65.8	15.4
1757	170	093079	3.05	68.2	14.2
1758	170	100379	3.77	25.0	7.6
1759	170	100779	3.37	67.0	11.0
1760	170	101079	3.36	37.0	9.0
1761	170	101479	2.90	22.0	10.0
1762	170	101779	2.90	42.6	13.0
1763	170	102379	2.86	29.4	8.2
1764	170	102579	2.78	21.2	1.4
1765	170	103079	3.05	90.8	1.2
1766	170	110179	2.38	32.0	8.0
1767	170	110679	3.07	149.4	10.8
1768	170	110879	2.40	168.0	10.4
1769	170	111379	3.41	26.0	6.0
1770	170	111579	2.90	52.0	3.0
1771	170	112079	2.86	32.0	2.0
1772	170	112279	2.93	44.0	4.2
1773	170	112779	2.89	96.0	9.0
1774	170	112979	2.79	194.0	10.2
1775	170	120479	3.17	150.0	18.0
1776	170	120679	3.19	.	22.0

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------------------------------------------ POLL=OAG ------------------------------------------

    OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

    1777    170    121179      3.23           257.0             18.0
    1778    170    121379      3.48             .               22.0
    1779    170    121879      2.63           126.0              7.4
    1780    170    122079      2.83            66.0             13.0
    1781    170    122579      3.43            80.6             23.4
    1782    170    122779      2.86            34.0             10.0
    1783    170    010180      3.38            18.2               .
    1784    170    010380      2.90           108.0               .
    1785    170    010880      3.05            30.0               .
    1786    170    011080      3.19           101.0               .
    1787    170    011680      3.31            75.0               .
    1788    170    011780      3.31            90.0               .
    1789    170    012280      2.90            26.0               .
    1790    170    012480      2.62            92.0               .
    1791    170    012980      3.01            96.0               .
    1792    170    013180      3.25            26.0               .
    1793    170    020580      3.14            62.0               .
    1794    170    021280      3.19           160.0               .
    1795    170    021480      2.95            29.4               .
    1796    170    021980      2.84            50.0               .
    1797    170    022280      3.20            87.0               .
    1798    170    022680      2.97            88.0               .
    1799    170    022880      3.04            86.0               .
    1800    170    030480      3.23            84.0               .
    1801    170    030680      3.46            96.0               .
    1802    170    031180      2.94           105.0               .
    1803    170    031380      3.42            52.0               .
    1804    170    031880      3.50            68.0               .
    1805    170    032080      3.78            67.6               .
    1806    170    032580      3.45            34.0               .
    1807    170    032780      1.96            25.0               .
    1808    170    040180      3.40            82.6               .
    1809    170    040380      3.37            64.2               .
    1810    170    040880      3.66            37.4               .
    1811    170    041680      2.90            18.0               .
    1812    170    041780      3.05            30.2               .
    1813    170    042280      3.31            49.0               .
    1814    170    042480      2.10            54.0               .
    1815    170    042980      2.70            94.2               .
    1816    170    050180      2.33            51.4               .
    1817    170    050680      2.47            20.0               .
    1818    170    050980      2.33            61.0               .
    1819    170    051380      2.16            22.2               .
    1820    170    051580      2.09            62.0               .
    1821    170    052080      2.54            28.0               .
    1822    170    052280      2.25            27.0               .
    1823    170    052780      2.00           108.0               .
    1824    170    052980      2.18            94.0               .
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--------------------------------------------------- POLL=TSS ------------------------------------------------------------

          OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

          1825      9     101575     0.05             36              31.0
          1826      9     102275     0.05             28              21.0
          1827      9     111275     0.25             41              47.0
          1828      9     111975     0.07             14              45.0
          1829      9     121075     0.06             22               6.0
          1830      9     121775     0.06              4              13.0
          1831      9     010776     0.10             13              13.0
          1832      9     011476      .               50              52.0
          1833      9     021176     0.07             31              20.0
          1834      9     021876      .               50              16.0
          1835      9     031076     0.08             25              41.0
          1836      9     032576      .               49              53.0
          1837      9     041476     0.06             19              20.0
          1838      9     042176      .               49              47.0
          1839      9     051276     0.09             27              17.0
          1840      9     051976      .               20              50.0
          1841      9     060976     0.13             57              41.2
          1842      9     061676     0.13             12              17.0
          1843      9     072176     0.07             14              15.0
          1844      9     072876     0.09             20              40.0
          1845      9     080476     0.05             11              40.0
          1846      9     081876     0.06             48              17.0
          1847      9     090876     0.02             10              17.0
          1848      9     092276      .                4              19.0
          1849     44     060179     0.92             88               3.0
          1850     44     060479     0.88            224              10.0
          1851     44     060579     1.00            268               9.0
          1852     44     060679     0.80            306              20.0
          1853     44     060779     0.38            212               6.0
          1854     44     060879     0.83            512              20.0
          1855     44     061179     0.94             18              11.0
          1856     44     061279     0.79            138              33.0
          1857     44     061379     0.80           3944              47.0
          1858     44     061479     1.13           1234              18.0
          1859     44     061579     0.45            508              22.0
          1860     44     061879     0.57            760              10.0
          1861     44     061979     0.71           1016              82.0
          1862     44     062079     0.39              .              33.0
          1863     44     062179     0.57              .               8.0
          1864     44     062279     0.36              .              16.0
          1865     44     062579     0.83              .               5.0
          1866     44     062679     0.68              .              21.0
          1867     44     062779     0.60              .               4.0
          1868     44     062879     0.62              .               9.0
          1869     44     062979     0.80              .               5.0
          1870     44     070279     0.81            176              17.0
          1871     44     070379     0.63             82              11.0
          1872     44     070479     0.51            896              17.0
          1873     44     070579     0.25            450              16.0
          1874     44     070679     0.34            602              30.0
          1875     44     070979     0.79            182               4.0
          1876     44     071079     0.71            300               7.0
          1877     44     071179     0.73            138              11.0
          1878     44     071279     0.74            390               8.0
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                         LISTING OF PMP DATA BY POLLUTANT                                        36

--------------------------------------------- POLL=TSS ---------------------------------------------

      OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

      1879     44     071379      0.80            830               5
      1880     44     071679      0.74            342               4
      1881     44     071779      0.79           5478               1
      1882     44     071879      0.73          10050               7
      1883     44     071979      0.73          15150              10
      1884     44     072079      0.90          11900               4
      1885     44     072379      0.54            410               4
      1886     44     072479      0.69            662              13
      1887     44     072579      0.73           1078               9
      1888     44     072679      0.81          15400              19
      1889     44     072779      0.71          10300              17
      1890     44     073079      0.79          17660               5
      1891     44     073179      0.43            314               5
      1892     44     080179      0.38            508               5
      1893     44     080279      0.46            690              18
      1894     44     080379      0.66           1258               3
      1895     44     080679      0.74            792               4
      1896     44     080779      0.26            272               7
      1897     44     080879      0.56            248              28
      1898     44     080979      0.73           1440               2
      1899     44     081079      0.75           2084              13
      1900     44     081379      0.74           1176               2
      1901     44     081479      0.65           2502               6
      1902     44     081579      0.79          20700               2
      1903     44     081679      0.73          17160               3
      1904     44     081779      0.84          20700               2
      1905     44     082079      0.83          17380              11
      1906     44     082179      0.85          21270               8
      1907     44     082279      0.73          11000              16
      1908     44     082379      0.67            706               8
      1909     44     082479      0.94           1846              13
      1910     44     082779      0.96           9000              10
      1911     44     082879      0.96          69600              14
      1912     44     082979      0.91           2160              11
      1913     44     083079      0.90           7320              54
      1914     44     083179       .               .               10
      1915     44     090379      0.19           3320               2
      1916     44     090479      0.34           8212               3
      1917     44     090579      0.28           3980               2
      1918     44     090679      0.39           2580               1
      1919     44     090779      0.33           1052               2
      1920     44     091079      0.62            430               5
      1921     44     091179      0.70           7140               2
      1922     44     091279      0.67          10560               1
      1923     44     091379      0.72          18940               2
      1924     44     091479      0.85          18820               2
      1925     44     091779      0.88          13380              25
      1926     44     091879      0.88           2860              83
      1927     44     091979      0.48           1900              10
      1928     44     092079      0.33           1080               6
      1929     44     092179      0.43           3240              14
      1930     44     092479      0.31           2900               3
      1931     44     092579      0.27          16100               5
      1932     44     092679      0.37           4020               2
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                          LISTING OF PMP DATA BY POLLUTANT

------------------------------------------------------------- POLL=TSS -----------------------------------------------------------

         OBS     PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

        1933       44     092779      0.36          11440              65
        1934       44     092879      0.35          19280              95
        1935       44     100179      0.55           4120              20
        1936       44     100279      0.57           3300              24
        1937       44     100379      0.45            182              34
        1938       44     100479      0.36            204              37
        1939       44     100579      0.57            680               4
        1940       44     100879      0.96           5420               6
        1941       44     100979      0.46            360              13
        1942       44     101079      0.64           5280              19
        1943       44     101179      0.70           1920               9
        1944       44     101279      0.58           4940              16
        1945       44     101579      0.23          10540              11
        1946       44     101679      0.67           9800              15
        1947       44     101779      0.67          12120              33
        1948       44     101879      0.60           6200              16
        1949       44     101979      0.62          12740              35
        1950       44     102279      0.60          13500              16
        1951       44     102379      0.68          20440              18
        1952       44     102479      0.69          14960              20
        1953       44     102579      0.60           1700              38
        1954       44     102679      0.59            560              34
        1955       44     102979      0.60           7360              25
        1956       44     103079      0.67          16060               6
        1957       44     103179      0.10           1380              28
        1958       44     110179      0.52            640              18
        1959       44     110279      0.72           1180               9
        1960       44     110579      0.58           2640              16
        1961       44     110679      0.59           1780               2
        1962       44     110779      0.68           3520              12
        1963       44     110879      0.69           2640              22
        1964       44     110979      0.53            580               4
        1965       44     111279      0.66           2460               7
        1966       44     111379      0.98           5640              24
        1967       44     111479      0.65           8160              22
        1968       44     111579      0.51            340              26
        1969       44     111679      0.51            760               4
        1970       44     111979      0.72           1260              21
        1971       44     112079      0.78           2560               9
        1972       44     112179      0.78           2100               4
        1973       44     112279      0.35            560               4
        1974       44     112379      0.11            640               3
        1975       44     112679      0.58           2620               1
        1976       44     112779      0.78           1750              12
        1977       44     112879      0.69           1185               1
        1978       44     112979      0.70           1480               5
        1979       44     113079      0.73           2620               2
        1980       44     120379      0.74           2300               2
        1981       44     120479      0.55           4360               5
        1982       44     120579      0.60           2060               1
        1983       44     120679      0.66            240               4
        1984       44     120779      0.70            920               2
        1985       44     121079      1.12           2080               1
        1986       44     121179      0.63           1360               1
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-- POLL=TSS --

OBS	PLANT	DATE	FLOW(MGD)	INFLUENT(PPM)	EFFLUENT(PPM)
1987	44	121279	0.79	1240	4
1988	44	121379	0.60	3760	1
1989	44	121479	0.63	5080	9
1990	44	121779	0.61	1000	2
1991	44	121879	0.58	1480	4
1992	44	121979	0.57	378	2
1993	44	122079	0.52	880	4
1994	44	122179	0.65	3880	1
1995	44	122479	0.36	100	2
1996	44	122579	0.47	940	5
1997	44	122679	0.41	720	5
1998	44	122779	0.30	380	6
1999	44	122879	0.41	400	8
2000	44	123179	0.63	.	12
2001	44	010180	0.53	1600	3
2002	44	010280	0.15	670	16
2003	44	010380	0.59	920	6
2004	44	010480	0.50	154	7
2005	44	010780	0.67	150	680
2006	44	010880	0.63	180	18
2007	44	010980	0.65	790	6
2008	44	011080	0.47	1255	4
2009	44	011180	0.69	744	14
2010	44	011480	0.32	160	7
2011	44	011580	0.60	360	6
2012	44	011680	0.76	480	2
2013	44	011780	0.74	720	6
2014	44	011880	0.56	1040	7
2015	44	012180	0.62	1440	4
2016	44	012280	0.60	940	3
2017	44	012380	0.65	280	25
2018	44	012480	0.53	220	2
2019	44	012580	0.61	280	2
2020	44	012880	0.56	260	2
2021	44	012980	0.48	186	11
2022	44	013080	0.43	340	2
2023	44	013180	0.54	160	1
2024	44	020180	0.67	100	2
2025	44	020480	0.87	90	17
2026	44	020580	0.55	122	4
2027	44	020680	0.49	55740	7
2028	44	020780	0.46	13400	2
2029	44	020880	0.44	1280	41
2030	44	021180	0.69	340	15
2031	44	021280	0.25	34100	3
2032	44	021380	0.51	80	2
2033	44	021480	0.63	180	3
2034	44	021580	0.57	260	4
2035	44	021680	0.47	13300	3
2036	44	021980	0.65	380	2
2037	44	022080	0.63	2780	2
2038	44	022180	0.74	3340	6
2039	44	022280	0.71	3520	65
2040	44	022580	0.89	3920	7

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                              LISTING OF FMP DATA BY POLLUTANT
------------------------------------------------------ POLL=TSS ------------------------------------------------------

      OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

      2041    44     022680      0.85           1840              10
      2042    44     022780      0.78           5500               2
      2043    44     022880      0.58           4320               6
      2044    44     030380      0.44           1920               7
      2045    44     030480      0.50           8080               7
      2046    44     030580      0.57            120               2
      2047    44     030680      0.61          15060               3
      2048    44     030780      1.04           2440               4
      2049    44     031080      0.79           1080               9
      2050    44     031180      0.64            340               2
      2051    44     031280      0.63            820               2
      2052    44     031380      0.82            140               2
      2053    44     031480      0.80           1060               2
      2054    44     031780      0.91           2940               2
      2055    44     031880      0.86            620               6
      2056    44     031980      0.82            760               8
      2057    44     032080      1.00            100               5
      2058    44     032180      0.97           7064               3
      2059    44     032480      0.62           3560               3
      2060    44     032580      0.78           1480              15
      2061    44     032680      0.75           2280               7
      2062    44     032780      0.71           1860               5
      2063    44     032880      0.82           3604               3
      2064    44     033180      0.73              .               4
      2065    44     040180      0.81             86              10
      2066    44     040280      0.82           4640               2
      2067    44     040380      0.56            800               7
      2068    44     040480      0.21            460               2
      2069    44     040780      0.64           1460               2
      2070    44     040880      0.90           4780              11
      2071    44     040980      0.71           1780               5
      2072    44     041080      0.92           1340               2
      2073    44     041180      0.93           1260               2
      2074    44     041480      0.95            780               3
      2075    44     041580      0.70            280               2
      2076    44     041680      0.74            580               2
      2077    44     041780      0.87            290               2
      2078    44     041880      0.86            780               2
      2079    44     042180      0.76            420               5
      2080    44     042280      0.55            160               2
      2081    44     042380      0.73            500               2
      2082    44     042480      0.73            460               2
      2083    44     042580      0.59            740               2
      2084    44     042880      0.62            680               7
      2085    44     042980      0.60            600               2
      2086    44     043080      0.62            380               4
      2087    44     050180      0.70            500               2
      2088    44     050280      0.67            460               2
      2089    44     050580      0.87           1460               2
      2090    44     050680      0.96            940               2
      2091    44     050780      0.87            260              10
      2092    44     050880      0.32            240              18
      2093    44     050980      0.60             80               9
      2094    44     051280      0.72            420              10
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------------------------------------------------------- POLL=TSS ------------------------------------------------------------------

          OBS     PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

          2095     44      051380      0.80           120                 4
          2096     44      051480      0.64           440                 5
          2097     44      051580      0.35           520                10
          2098     44      051680      0.60           720                 7
          2099     44      051980      0.50           350                 3
          2100     44      052080      0.25            80                 2
          2101     44      052180      0.11            30                12
          2102     44      052280      0.57            20               320
          2103     44      052380      0.44           310                25
          2104     44      052680      0.30           310                10
          2105     44      052780      0.48            60                 2
          2106     44      052880      0.54            30                 2
          2107     44      052980       .              20                44
          2108     44      053080       .              40                59
          2109     45      070279      2.17            12                 2
          2110     45      070379      1.73             6                 4
          2111     45      070479      1.46            26                22
          2112     45      070579      2.13            26                10
          2113     45      070679      1.90             .                12
          2114     45      070779      2.11             .                10
          2115     45      070879      2.24            14                16
          2116     45      070979      2.26            90                64
          2117     45      071079      2.35           306                54
          2118     45      071179      2.84           110                26
          2119     45      071279      2.95           136                46
          2120     45      071379      3.26             .                10
          2121     45      071479      3.43             .                 6
          2122     45      071579      2.49            44                12
          2123     45      071679      2.47            22                 8
          2124     45      071779      2.07            66                10
          2125     45      071879      2.43            40                10
          2126     45      071979      2.70            38                 8
          2127     45      072079      2.55             .                 4
          2128     45      072179      2.48             .                10
          2129     45      072279      2.45            60                 6
          2130     45      072379      3.28             6                10
          2131     45      072479      3.43            20                16
          2132     45      072579      3.17           522                22
          2133     45      072679      3.26           980                10
          2134     45      072779      3.24             .                 4
          2135     45      072879      3.07             .                 4
          2136     45      072979      3.20            94                 6
          2137     45      073079      3.20            62                10
          2138     45      073179      3.12           496                 6
          2139     45      080179      3.03           104                 4
          2140     45      080279      2.87           534                 6
          2141     45      080379      2.97             .                 6
          2142     45      080479      3.18             .                 6
          2143     45      080579      2.98           446                 4
          2144     45      080679      3.10           320                 4
          2145     45      080779      2.94           556                30
          2146     45      080879      3.04           668                 8
          2147     45      080979      2.48           618                10
          2148     45      081079      3.21                              46
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                                   LISTING OF PMP DATA BY POLLUTANT
------------------------------------------------ POLL=TSS ---------------------------------------------- 41
          OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

          2149     45     081279     2.90            672               44
          2150     45     081379     2.66            480               42
          2151     45     081479     2.71            564               20
          2152     45     081579     2.56            398               14
          2153     45     081679     2.62            412                4
          2154     45     081779     2.73              .               20
          2155     45     081879     2.63              .                6
          2156     45     081979     2.52            494                2
          2157     45     082079     2.87            512               10
          2158     45     082179     3.41            482                4
          2159     45     082279     3.62            552               10
          2160     45     082379     3.56            398                8
          2161     45     082479     3.58              .                8
          2162     45     082579     3.29              .               12
          2163     45     082679     2.55             64                8
          2164     45     082779     3.01             36               10
          2165     45     082879     2.63             80                4
          2166     45     082979     2.56             82                6
          2167     45     083079     3.40            128               18
          2168     45     083179     2.72              .               20
          2169     45     090179     2.21              .               14
          2170     45     090279     2.00             86               16
          2171     45     090379     0.63           1118                6
          2172     45     090479     1.61             72               18
          2173     45     090579     2.21             74                8
          2174     45     090679     2.86             52                4
          2175     45     090779     2.82              .               30
          2176     45     090879     2.34              .               46
          2177     45     090979     1.88            202               20
          2178     45     091079     2.39            224                6
          2179     45     091179     2.44             48                4
          2180     45     091279     1.92             48               14
          2181     45     091379     1.85             68                4
          2182     45     091479     1.98              .               28
          2183     45     091579     2.40              .               32
          2184     45     091679     2.44             82               40
          2185     45     091779     2.37             44               10
          2186     45     091879     2.39             26                4
          2187     45     091979     1.86             24                6
          2188     45     092079     3.04             74                2
          2189     45     092179     2.91              .               12
          2190     45     092279     3.06              .               14
          2191     45     092379     2.73            220               10
          2192     45     092479     2.52             56               12
          2193     45     092579     2.85             72               14
          2194     45     092679     2.77             70                4
          2195     45     092779     2.52             44               10
          2196     45     092879     2.45              .               24
          2197     45     092979     2.60              .               14
          2198     45     093079     2.49             36               22
          2199     45     100179     2.32             54               14
          2200     45     100279     2.24             92               28
          2201     45     100379     2.27             62                8
          2202     45     100479     2.66             12                6
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                         LISTING OF PMP DATA BY POLLUTANT

------------------------------------------------ POLL=TSS ------------- --- ------------------------------------------

          OBS     PLANT     DATE     FLOW(MGD)   INFLUENT(PPM)   EFFLUENT(PPM)

          2203     45      100579      2.44            .              72
          2204     45      100679      2.19            .              66
          2205     45      100779      2.01          128              48
          2206     45      100879      1.90           70              40
          2207     45      100979      2.18           48              44
          2208     45      101079      2.52           28              18
          2209     45      101179      2.18           66               6
          2210     45      101279      1.96            .               6
          2211     45      101379      1.70            .               6
          2212     45      101479      1.65           60               8
          2213     45      101579      1.46          298              10
          2214     45      101679      2.10          350              34
          2215     45      101779      1.95          130              18
          2216     45      101879      1.42          500               8
          2217     45      101979      1.46            .              42
          2218     45      102079      1.59            .              38
          2219     45      102179      1.57          274              28
          2220     45      102279      1.61          284              32
          2221     45      102379      2.26          278               2
          2222     45      102479      1.22          206               2
          2223     45      102579      1.55          264               2
          2224     45      102679      1.50            .              22
          2225     45      102779      1.20            .              12
          2226     45      102879      0.84          204              16
          2227     45      102979      1.15          446               6
          2228     45      103079      2.26          234              10
          2229     45      103179      1.86          110               4
          2230     45      110179      1.56           74              18
          2231     45      110279      1.57            .               4
          2232     45      110379      1.31            .               8
          2233     45      110479      0.70          280               6
          2234     45      110579      0.92          108               6
          2235     45      110679      1.59          132              24
          2236     45      110779      1.57          492              46
          2237     45      110879      1.73          122              10
          2238     45      110979      1.78            .              12
          2239     45      111079      1.68            .               6
          2240     45      111179      1.40           18              10
          2241     45      111279      2.35          146              26
          2242     45      111379      2.17           76               4
          2243     45      111479      1.41          216              12
          2244     45      111579      1.19          142              30
          2245     45      111679      2.02            .              10
          2246     45      111779      2.03            .              18
          2247     45      111879      1.55          470              12
          2248     45      111979      1.19           72              22
          2249     45      112079      1.65           76              18
          2250     45      112179      1.49            .               8
          2251     45      112279      0.96           82              10
          2252     45      112379      0.93            .              36
          2253     45      112479      2.06            .              28
          2254     45      112579      2.11           74              26
          2255     45      112679      1.30           70              54
          2256     45      112779      1.36           52              30
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------------------------------------------------------- POL: =TSS ------------------------------------------------------------

      OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

     2257     45     112879       1.48            64               14
     2258     45     112979       2.01            76               10
     2259     45     113079       1.93             .               14
     2260     45     120179       1.77             .               10
     2261     45     120279       1.63             6                6
     2262     45     120379       1.56           322                6
     2263     45     120479       1.36           318               20
     2264     45     120579       1.38           304               36
     2265     45     120679       1.54           190                6
     2266     45     120779       1.80             .               28
     2267     45     120879       1.65             .               18
     2268     45     120979       1.37           214               10
     2269     45     121079       2.14           138                2
     2270     45     121179       2.12           180                4
     2271     45     121279       2.03           534                6
     2272     45     121379       2.21           208               16
     2273     45     121479       2.23             .               34
     2274     45     121579       1.73             .               22
     2275     45     121679       1.80           312               26
     2276     45     121779       1.78           436               14
     2277     45     121879       2.09           198               22
     2278     45     121979       2.20           226                4
     2279     45     122079       2.22            22               14
     2280     45     122179       1.95             .               16
     2281     45     122279       1.52             .               12
     2282     45     122379       1.55           214                8
     2283     45     122479       0.88             .               14
     2284     45     122579       1.04            50               34
     2285     45     122679       1.65           266               24
     2286     45     122779       2.09           238                2
     2287     45     122879       1.93             .               46
     2288     45     122979       1.70             .               46
     2289     45     123079       1.24           318               42
     2290     45     123179       0.95             .                4
     2291     45     010180       0.74           604                4
     2292     45     010280       2.06           166               18
     2293     45     010380       1.93           300                4
     2294     45     010480       1.57             .                2
     2295     45     010580       1.43             .                2
     2296     45     010680       1.62            88                4
     2297     45     010780       1.76            52                2
     2298     45     010880       1.61           554                4
     2299     45     010980       1.74           132                4
     2300     45     011080       1.60           432                2
     2301     45     011180       1.72             .                6
     2302     45     011280       1.82             .                2
     2303     45     011380       1.80            24                4
     2304     45     011480       1.60            22                2
     2305     45     011580       1.59             2                4
     2306     45     011680       1.55           458                2
     2307     45     011780       1.53           128                6
     2308     45     011880       1.87             .               32
     2309     45     011980       1.39             .               28
     2310     45     012080       1.35           748               18
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------------------------------------ POL =TSS ------------------------------------

  OBS      PLANT      DATE      FLOW(MGD)      INFLUENT(PPM)      EFFLUENT(PPM)

  2311       45      012180       1.59             416                28
  2312       45      012280       1.72              90                42
  2313       45      012380       1.91              74                10
  2314       45      012480       1.47             164                 2
  2315       45      012580       1.67               .                 4
  2316       45      012680       1.55               .                 2
  2317       45      012780       1.53             356                 2
  2318       45      012880       1.66             182                 2
  2319       45      012980       1.80             190                 2
  2320       45      013080       1.66             250                28
  2321       45      013180       1.64             426                48
  2322       45      020180       1.55               .                26
  2323       45      020280       1.40               .                14
  2324       45      020380       1.69             594                26
  2325       45      020480       1.98            1336                 2
  2326       45      020580       1.64             472                46
  2327       45      020680       1.48             482                 2
  2328       45      020780       1.98             504                 2
  2329       45      020880       1.90               .                 6
  2330       45      020980       2.02               .                 2
  2331       45      021080       1.80             260                 2
  2332       45      021180       1.68             380                 2
  2333       45      021280       2.02             206                 4
  2334       45      021380       2.15              20                 4
  2335       45      021480       1.92              50                 6
  2336       45      021580       1.70               .                 6
  2337       45      021680       2.36               .                 4
  2338       45      021780       2.25             458                 4
  2339       45      021880       1.36             422                10
  2340       45      021980       1.93              74                18
  2341       45      022080       2.13             256                 8
  2342       45      022180       1.66             294                 8
  2343       45      022280       1.28               .                28
  2344       45      022380       1.88               .                14
  2345       45      022480       1.57             262                 2
  2346       45      022580       2.02             392                 8
  2347       45      022680       1.40             398                50
  2348       45      022780       1.70             422                74
  2349       45      022880       1.06             256                28
  2350       45      022980       1.51               .                36
  2351       45      030180       1.80               .                62
  2352       45      030280       1.61             404                24
  2353       45      030380       2.23             432                 6
  2354       45      030480       1.57             420                14
  2355       45      030580       1.72             346                32
  2356       45      030680       1.55             326                42
  2357       45      030780       2.19               .                20
  2358       45      030880       2.21               .                 4
  2359       45      030980       1.60              28                 6
  2360       45      031080       1.88             300                56
  2361       45      031180       2.58            2692                20
  2362       45      031280       2.20              22                 6
  2363       45      031380       2.05             102                42
  2364       45      031480       2.63               .                16
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------------------------------------------------------------ POLL=TSS -------------------------------------------------------------

            OBS     PLANT     DATE     FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

            2365     45      031580       2.48                                8
            2366     45      031680       2.18            256                 8
            2367     45      031780       1.53            320                 2
            2368     45      031880       2.03             62                18
            2369     45      031980       2.23            232                14
            2370     45      032080       2.40             60                26
            2371     45      032180       2.51              .                 2
            2372     45      032280       2.08              .                 4
            2373     45      032380       2.23            358                 2
            2374     45      032480       1.55            372                 2
            2375     45      032580       1.55            296                58
            2376     45      032680       1.68             72                 2
            2377     45      032780       1.67            516                32
            2378     45      032880       2.18              .                22
            2379     45      032980       2.52              .                22
            2380     45      033080       2.17             10                14
            2381     45      033180       2.00            200                10
            2382     45      040180       2.07             16                 4
            2383     45      040280       1.54            134                48
            2384     45      040380       1.53             60                36
            2385     45      040480       0.41              .                40
            2386     45      040580       0.60              .                38
            2387     45      040680       2.33            162                30
            2388     45      040780       1.76            272                 2
            2389     45      040880       1.85            124                36
            2390     45      040980       1.86             46                 8
            2391     45      041080       1.83            152                18
            2392     45      041180       1.77              .                24
            2393     45      041280       1.77              .                30
            2394     45      041350       2.04            122                14
            2395     45      041480       2.08             90                12
            2396     45      041580       1.67            152                94
            2397     45      041680       2.80             80                 8
            2398     45      041780       2.51            152                18
            2399     45      041880       1.82              .                24
            2400     45      041980       1.50              .                34
            2401     45      042080       1.70             70                44
            2402     45      042180       1.99             62                42
            2403     45      042280       2.01            866                 4
            2404     45      042380       1.93             12                 2
            2405     45      042480       1.44             70                 6
            2406     45      042580       1.43              .                24
            2407     45      042680       1.42              .                18
            2408     45      042780       1.48            254                20
            2409     45      042880       1.45            550                 2
            2410     45      042980       1.76            100                20
            2411     45      043080       2.05            102                48
            2412     45      050180       1.72            480                 4
            2413     45      050280       1.41              .                 2
            2414     45      050380       1.89              .                 2
            2415     45      050480       2.29            346                 4
            2416     45      050580       1.60             46                14
            2417     45      050680       1.91             40                 2
            2418     45      050780       2.30             32                 2
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                              LISTING OF PMP DATA BY POLLUTANT

----------------------------------------------------- POLL=TSS ------------------------------------------------------

          OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

          2419    45     050880      2.14             94               18
          2420    45     050980      1.42              .                4
          2421    45     051080      1.32              .                2
          2422    45     051180      1.25             56                2
          2423    45     051280      1.66            120                2
          2424    45     051380      1.88            452               72
          2425    45     051480      1.93             76               38
          2426    45     051580      1.53            748               48
          2427    45     051680      1.66              .                6
          2428    45     051780      1.79              .                2
          2429    45     051880      1.60            988                4
          2430    45     051980      1.22            282               56
          2431    45     052080      1.23            700               54
          2432    45     052180      1.17            336                2
          2433    45     052280      0.87            558               20
          2434    45     052380      1.26              .               18
          2435    45     052480      1.61              .               10
          2436    45     052580      1.13              .               18
          2437    45     052660      0.85            688              112
          2438    45     052780      1.30           2334               72
          2439    45     052880      1.67           3758               36
          2440    45     052980      0.99            930                4
          2441    45     053080      1.05              .                2
          2442    45     053160      1.15              .                6
          2443    45     060180      1.32            590               12
          2444    45     060280      1.11            278                8
          2445    45     060380      1.01            378               22
          2446    45     060480      0.93           1076               56
          2447    45     060580      0.90            530               14
          2448    45     060680      1.02              .                2
          2449    45     060780      1.45              .                4
          2450    45     060880      1.20           2692                6
          2451    45     060980      1.24            898               72
          2452    45     061080      1.45           1014               58
          2453    45     061180      1.48            794               32
          2454    45     061280      1.66            234               10
          2455    45     061380      1.17              .                4
          2456    45     061480      1.35              .               10
          2457    45     061580      1.40            302               12
          2458    45     061680      1.36            666               84
          2459    45     061780      1.34            140               50
          2460    45     061880      1.41            510               48
          2461    45     061980      1.45            680               82
          2462    45     062080      1.48              .               24
          2463    45     062180      1.82              .               26
          2464    45     062280      1.70            447               24
          2465    45     062380      1.49             86                8
          2466    45     062480      1.26            124                2
          2467    45     062580      1.21            366                2
          2468    45     062680      1.64            902                6
          2469    45     062780      2.19              .               38
          2470    45     062880      1.91              .               42
          2471    45     062980      1.68            598               26
          2472    45     063080      1.53            720                2
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-------------------------------------------- POLL=TSS ---------------------------------------------------

            OBS     PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

            2527      96     082776       2.70             .               16
            2528      96     083076       2.60             .                3
            2529      96     090176       2.60             .               10
            2530      96     090276       2.60             .                8
            2531      96     090776       1.60             .               14
            2532      96     091376       2.20             .               18
            2533      96     091476       2.30             .               21
            2534      96     091676       2.60             .               16
            2535      96     092076       2.50             .               19
            2536      96     092276       2.30             .               17
            2537      96     092876       2.60             .               11
            2538      96     092976       2.40             .               19
            2539     111     010177       1.01             .               10
            2540     111     010277       0.90             .                3
            2541     111     010377       1.05             .                7
            2542     111     010477       0.83            70               30
            2543     111     010577       0.96            90               20
            2544     111     010677       0.93           100                6
            2545     111     010777       0.93             .                7
            2546     111     010877       0.93             .                3
            2547     111     010977       0.99             .               19
            2548     111     011077       0.90             .                5
            2549     111     011177       0.91            80                5
            2550     111     011477       1.16             .                2
            2551     111     011577       0.93             .               17
            2552     111     011677       1.10             .               14
            2553     111     011777       1.11             .                3
            2554     111     011877       0.78            40                3
            2555     111     011977       0.93            70               45
            2556     111     012077       0.65            80                7
            2557     111     012177       1.08             .               16
            2558     111     012277       1.06             .               17
            2559     111     012377       1.12             .               24
            2560     111     012577       0.84            60                8
            2561     111     012677       0.99            50               11
            2562     111     012777       0.98            70                9
            2563     111     012877       1.08             .                6
            2564     111     012977       0.98             .               10
            2565     111     013077       0.97             .               12
            2566     111     013177       0.97             .                3
            2567     111     020177       0.69            65                3
            2568     111     020277       0.61            75                7
            2569     111     020377       0.73            70                9
            2570     111     020477       0.59             .                3
            2571     111     020577       1.09             .                9
            2572     111     020677       1.14             .                9
            2573     111     020777       1.13             .               15
            2574     111     020977       0.99            52               16
            2575     111     021077       0.96            55                7
            2576     111     021177       0.77             .               20
            2577     111     021277       0.73             .               35
            2578     111     021377       0.82             .               25
            2579     111     021477       0.78             .               38
            2580     111     021577       0.92            40                6
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                          LISTING OF PMP DATA BY POLLUTANT

---------------------------------------------- POL =TSS ----------------------------------------------

     OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

    2473     96     100875       3.2             .               28
    2474     96     101375       3.2             .               46
    2475     96     102775       3.2             .               43
    2476     96     110375       3.3             .               18
    2477     96     111075       3.3             .               15
    2478     96     111475       3.1             .                3
    2479     96     111875       3.4             .                4
    2480     96     112575       3.4             .                2
    2481     96     120275       3.4             .               18
    2482     96     120475       3.3             .               12
    2483     96     120775       3.4             .                7
    2484     96     120875       3.4             .                9
    2485     96     121275       3.0             .               17
    2486     96     121575       3.0             .               33
    2487     96     121675       3.0             .               16
    2488     96     121875       3.1             .                9
    2489     96     122275       3.3             .                9
    2490     96     122975       3.5             .               19
    2491     96     010776       3.4             .                8
    2492     96     010976       3.4             .               12
    2493     96     012076       3.4             .               10
    2494     96     020576       3.3             .               15
    2495     96     022476       3.4             .                8
    2496     96     030276       3.5             .               13
    2497     96     030976       3.2             .                4
    2498     96     031176       3.1             .               10
    2499     96     032676       3.2             .                6
    2500     96     040576       3.4             .                5
    2501     96     041276       3.0             .                3
    2502     96     041976       3.5             .               11
    2503     95     042376       3.1             .               20
    2504     96     050476       3.1             .               11
    2505     96     051376       3.0             .                8
    2506     96     051976       3.1             .                5
    2507     96     052576       3.1             .               12
    2508     96     060376       3.0             .                6
    2509     96     060776       3.0             .               14
    2510     96     060976       3.1             .                5
    2511     96     061576       3.1             .                7
    2512     96     061876       3.0             .               10
    2513     96     062476       2.9             .                9
    2514     96     062976       3.1             .               11
    2515     96     070876       3.0             .                4
    2516     96     071276       3.0             .               10
    2517     96     071576       3.0             .               20
    2518     96     071976       3.0             .               14
    2519     96     072276       2.8             .                7
    2520     96     072676       2.9             .                6
    2521     96     072876       2.8             .                6
    2522     96     080476       2.8             .               11
    2523     96     081276       3.1             .                6
    2524     96     081676       3.1             .                3
    2525     96     082376       2.7             .                6
    2526     96     082676       2.8             .               11
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                           LISTING OF PMP DATA BY POLLUTANT                                 48

----------------------------------------------- POLL=TSS ---------------------------------------------

             OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

            2527      96     082776      2.70              .              16
            2528      96     083076      2.60              .               3
            2529      96     090176      2.60              .              10
            2530      96     090276      2.60              .               8
            2531      96     090776      1.60              .              14
            2532      96     091376      2.20              .              18
            2533      96     091476      2.30              .              21
            2534      96     091676      2.60              .              16
            2535      96     092076      2.50              .              19
            2536      96     092276      2.30              .              17
            2537      96     092876      2.60              .              11
            2538      96     092976      2.40              .              19
            2539     111     010177      1.01              .              10
            2540     111     010277      0.90              .               3
            2541     111     010377      1.05              .               7
            2542     111     010477      0.83             70              30
            2543     111     010577      0.96             90              20
            2544     111     010677      0.93            100               6
            2545     111     010777      0.93              .               7
            2546     111     010877      0.93              .               3
            2547     111     010977      0.99              .              19
            2548     111     011077      0.90              .               5
            2549     111     011177      0.91             80               5
            2550     111     011477      1.16              .               2
            2551     111     011577      0.93              .              17
            2552     111     011677      1.10              .              14
            2553     111     011777      1.11              .               3
            2554     111     011877      0.78             40               3
            2555     111     011977      0.98             70              45
            2556     111     012077      0.65             80               7
            2557     111     012177      1.08              .              16
            2558     111     012277      1.06              .              17
            2559     111     012377      1.12              .              24
            2560     111     012577      0.84             60               8
            2561     111     012677      0.99             50              11
            2562     111     012777      0.98             70               9
            2563     111     012877      1.08              .               6
            2564     111     012977      0.98              .              10
            2565     111     013077      0.97              .              12
            2566     111     013177      0.97              .               3
            2567     111     020177      0.69             65               3
            2568     111     020277      0.61             75               7
            2569     111     020377      0.73             70               9
            2570     111     020477      0.59              .               3
            2571     111     020577      1.09              .               9
            2572     111     020677      1.14              .               9
            2573     111     020777      1.13              .              15
            2574     111     020977      0.99             52              16
            2575     111     021077      0.96             55               7
            2576     111     021177      0.77              .              20
            2577     111     021277      0.73              .              35
            2578     111     021377      0.82              .              25
            2579     111     021477      0.78              .              38
            2580     111     021577      0.92             40               6
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                                         LISTING OF PMP DATA BY POLLUTANT                                              49
------------------------------------------------------- POLL=TSS -------------------------------------------------------

              OBS     PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

              2581     111     021677      0.69            45                8.0
              2582     111     021777      1.00            38               12.0
              2583     111     021877      0.83             .               20.0
              2584     111     021977      1.03             .               50.0
              2585     111     022077      0.87             .                3.0
              2586     111     022177      0.99             .                7.0
              2587     111     022277      0.74            45               18.0
              2588     111     022377      1.14            42               16.0
              2589     111     022477      1.08            50                6.0
              2590     111     022577      1.19             .                4.0
              2591     111     022677      1.06             .                5.0
              2592     111     022777      0.90             .                5.0
              2593     111     022877      0.82             .                5.0
              2594     111     030177      0.74            40                0.5
              2595     111     030277      0.68            43                5.0
              2596     111     030377      0.43            40               13.0
              2597     111     030577      0.39             .               16.0
              2598     111     030677      0.83             .                6.0
              2599     111     030777      0.85             .                5.0
              2600     111     030877      0.73            45                5.0
              2601     111     030977      0.57            40               12.0
              2602     111     031077      1.15            30                4.0
              2603     111     031177      1.33             .               14.0
              2604     111     031277      1.31             .                4.0
              2605     111     031377      1.29             .               16.0
              2606     111     031477      1.01             .                4.0
              2607     111     031577      1.37            20               10.0
              2608     111     031677      1.01            33               71.0
              2609     111     031777      1.15            35               19.0
              2610     111     031877      1.07             .                6.0
              2611     111     031977      1.25             .               19.0
              2612     111     032077      1.21             .               11.0
              2613     111     032177      1.19             .               14.0
              2614     111     032277      1.11            20                1.0
              2615     111     032377      1.06            18               13.0
              2616     111     032477      0.96            22                7.0
              2617     111     032577      0.95             .                7.0
              2618     111     032777      1.07             .                6.0
              2619     111     032877      1.15             .                5.0
              2620     111     032977      0.98            20               15.0
              2621     111     033077      0.80            30                2.0
              2622     111     033177      0.95            33                2.0
              2623     111     040177      0.93             .                8.0
              2624     111     040277      1.04             .                3.0
              2625     111     040377      1.13             .                9.0
              2626     111     040477      0.93            45                5.0
              2627     111     040577      1.15            35                9.0
              2628     111     040577      0.74            37                5.0
              2629     111     040777      1.34             .                8.0
              2630     111     040877      1.22             .                9.0
              2631     111     040977      1.28             .               17.0
              2632     111     041077      1.17             .               13.0
              2633     111     041177      1.23             .                5.0
              2634     111     041277      0.92            35                2.0
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----------------------------------------------------- POLL=TSS -----------------------------------------------------

 OBS     PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

 2635     111     041377      1.10           31               36
 2636     111     041477      0.87           34               16
 2637     111     041577      1.06            .               15
 2638     111     041677      1.03            .               12
 2639     111     041777      0.90            .               13
 2640     111     041877      1.04            .                5
 2641     111     041977      0.45           16                8
 2642     111     042077      0.94           27                5
 2643     111     042177      1.02           36                7
 2644     111     042277      0.87            .                9
 2645     111     042377      0.96            .                2
 2646     111     042477      0.80            .               16
 2647     111     042577      0.69            .               16
 2648     111     042677      0.83           29                5
 2649     111     042777      0.96           30                4
 2650     111     042877      0.55           26                1
 2651     111     043077      1.19            .                7
 2652     111     050177      0.90            .                3
 2653     111     050277      0.74            .                1
 2654     111     050777      1.11            .                1
 2655     111     050877      0.79            .                3
 2656     111     050977      1.00            .                1
 2657     111     051077      0.82           20                1
 2658     111     051177      0.72           10                3
 2659     111     051277      0.75           20                6
 2660     111     051377      0.75            .                7
 2661     111     051477      1.18            .                2
 2662     111     051577      1.16            .                2
 2663     111     051677      0.91            .               10
 2664     111     051777      0.93           20                8
 2665     111     051877      0.93           18               19
 2666     111     051977      0.87           14                4
 2667     111     052077      0.95            .               11
 2668     111     052177      0.91            .               15
 2669     111     052277      0.94            .               26
 2670     111     052377      0.95            .               13
 2671     111     052477      0.98           19                5
 2672     111     052577      1.07           10               10
 2673     111     052677      1.17           17                9
 2674     111     052777      0.98            .                9
 2675     111     052877      1.10            .                8
 2676     111     052977      1.16            .               13
 2677     111     053077      1.09            .                8
 2678     111     053177      1.03           32                1
 2679     111     060177      0.85           39                2
 2680     111     060277      1.17           64                5
 2681     111     060377      0.96            .                5
 2682     111     060477      1.06            .                1
 2683     111     060577      0.98            .                1
 2684     111     060677      0.98            .               16
 2685     111     060777      1.09           31               13
 2686     111     060877      1.08           36                9
 2687     111     060977      0.77           40               16
 2688     111     061077      1.08            .                9
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------------------------------------------------------------ POLL=TSS ------------------------------------------------------------

OBS     PLANT     DATE      FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

2689     111     061177       0.99             .               11
2690     111     061277       0.89             .               22
2691     111     061377       1.10             .               13
2692     111     061477       0.85            15                5
2693     111     061577       0.82            21               16
2694     111     061677       0.84            19               14
2695     111     061777       0.86             .                5
2696     111     061877       0.76             .                9
2697     111     061977       0.76             .               11
2698     111     062077       0.68             .                8
2699     111     062177       0.42            35                7
2700     111     062277       0.92            40                7
2701     111     062377       1.01            45                9
2702     111     062477       0.98             .               17
2703     111     062577       0.84             .               12
2704     111     062677       1.13             .               25
2705     111     062777       1.05             .                7
2706     111     062877       1.01            37                6
2707     111     062977       0.62            42                6
2708     111     070177       1.08             .                4
2709     111     070277       0.80             .                3
2710     111     070377       0.83             .               13
2711     111     070477       0.80             .               13
2712     111     070577       0.66            58                6
2713     111     070677       0.74            45               11
2714     111     070777       0.67            29               16
2715     111     070877       0.58             .               12
2716     111     070977       0.76             .                6
2717     111     071077       0.93             .                9
2718     111     071177       0.83             .               10
2719     111     071277       0.82            60                9
2720     111     071377       0.99            40                3
2721     111     071477       1.01            54                2
2722     111     071577       0.86             .                1
2723     111     071677       0.94             .                2
2724     111     071777       0.89             .                8
2725     111     071877       0.88             .                5
2726     111     071977       0.88            43                7
2727     111     072077       0.85            50                4
2728     111     072177       0.97            44                4
2729     111     072277       0.87             .                8
2730     111     072377       1.17             .               10
2731     111     072477       1.12             .                6
2732     111     072577       1.00             .               13
2733     111     072677       0.74            27               37
2734     111     072777       0.96            26               10
2735     111     072877       0.93            37               48
2736     111     072977       0.61             .                7
2737     111     073077       1.11             .                2
2738     111     073177       1.01             .               15
2739     111     080177       0.79             .               10
2740     111     080277       1.08            34                4
2741     111     080377       1.09            43                5
2742     111     080477       1.09            50                5
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                              LISTING OF PMP DATA BY POLLUTANT
---------------------------------------------------- POLL=TSS -----------------------------------------------------
           OBS    PLANT    DATE     FLOW(MGD)   INFLUENT(PPM)   EFFLUENT(PPM)

          2743     111    080577      1.20            .               9
          2744     111    080677      1.15            .               5
          2745     111    080777      1.27            .              16
          2746     111    080877      1.11            .               5
          2747     111    080977      1.03           42               5
          2748     111    081077      0.93           38              25
          2749     111    081177      0.92           40               9
          2750     111    081277      0.97            .               2
          2751     111    081377      1.07            .               5
          2752     111    081477      0.90            .               5
          2753     111    081577      0.83            .               2
          2754     111    081677      0.99           42               1
          2755     111    081777      0.87           48               7
          2756     111    081877      1.16           40              32
          2757     111    081977      1.02            .               5
          2758     111    082077      0.96            .              26
          2759     111    082177      0.91            .               4
          2760     111    082277      0.83            .               1
          2761     111    082377      0.75           38               2
          2762     111    082477      0.74           51               6
          2763     111    082677      1.11            .              18
          2764     111    082777      0.85            .               6
          2765     111    082877      0.97            .               2
          2766     111    082977      0.81            .               6
          2767     111    083077      0.85           47               2
          2768     111    083177      0.80           48              10
          2769     111    090177      0.76           40               7
          2770     111    090277      0.95            .               8
          2771     111    090377      1.06            .               6
          2772     111    090477      1.06            .               2
          2773     111    090577      0.83            .               5
          2774     111    090677      1.00           37               6
          2775     111    090777      1.01           32               1
          2776     111    090877      0.84           33               3
          2777     111    090977      1.23            .               9
          2778     111    091077      1.03            .               3
          2779     111    091177      0.89            .               1
          2780     111    091277      0.88            .              14
          2781     111    091377      1.15           22               1
          2782     111    091477      0.97           64               5
          2783     111    091577      0.67           32               1
          2784     111    091677      0.80            .               2
          2785     111    091777      0.91            .               3
          2786     111    091877      0.78            .               6
          2787     111    091977      0.84            .               7
          2788     111    092077      1.10           38               6
          2789     111    092177      1.12           33               6
          2790     111    092277      1.30           30               3
          2791     111    092377      1.05            .               7
          2792     111    092477      1.31            .               4
          2793     111    092577      1.10            .               5
          2794     111    092677      0.74            .              10
          2795     111    092777      0.67           35               3
          2796     111    092877      0.95           40              14
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                                    LISTING OF IMP DATA BY POLLUTANT                                          53

------------------------------------------------------ POLL=TSS ------------------------------------------------------

                 OBS      PLANT      DATE      FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

                 2797      111      092977       0.91             36                44
                 2798      111      093077       1.02              .                 6
                 2799      111      100177       0.97              .                 3
                 2800      111      100277       0.90              .                 8
                 2801      111      100377       1.00              .                 9
                 2802      111      100477       0.76             43                16
                 2803      111      100577       1.02             42                 7
                 2804      111      100677       0.88             45                 4
                 2805      111      100777       0.94              .                 2
                 2806      111      100877       0.96              .                 5
                 2807      111      100977       0.91              .                 7
                 2808      111      101077       0.84              .                 6
                 2809      111      101177       0.76             49                 2
                 2810      111      101277       0.86             48                10
                 2811      111      101377       1.04             47                10
                 2812      111      101477       1.03              .                 3
                 2813      111      101577       0.90              .                 7
                 2814      111      101677       1.13              .                 8
                 2815      111      101777       0.91              .                13
                 2816      111      101877       1.10             40                11
                 2817      111      101977       0.58             39                10
                 2818      111      102077       0.85             37                13
                 2819      111      102177       1.02              .                13
                 2820      111      102277       1.05              .                20
                 2821      111      102377       0.91              .                33
                 2822      111      102477       1.03              .                24
                 2823      111      102577       0.86             36                22
                 2824      111      102677       0.92             47                11
                 2825      111      102777       0.72             54                18
                 2826      111      102977       0.88              .                 4
                 2827      111      103077       0.99              .                 6
                 2828      111      103177       0.85              .                 4
                 2829      111      110177       0.81             41                15
                 2830      111      110277       0.93             56                19
                 2831      111      110377       1.18             48                15
                 2832      111      110477       1.14              .                14
                 2833      111      110577       1.05              .                10
                 2834      111      110677       1.07              .                18
                 2835      111      110777       0.96              .                 8
                 2836      111      110877       0.87             42                 2
                 2837      111      110977       1.01             33                11
                 2838      111      111077       1.02             40                 7
                 2839      111      111277       0.90              .                20
                 2840      111      111377       0.93              .                14
                 2841      111      111477       0.76              .                 9
                 2842      111      111577       0.91             69                 5
                 2843      111      111777       0.86             58                11
                 2844      111      111877       0.88              .                 7
                 2845      111      112077       0.72             48                 1
                 2846      111      112177       0.82             73                 1
                 2847      111      112277       0.79             55                12
                 2848      111      112377       0.65             50                10
                 2849      111      112477       0.87              .                32
                 2850      111      112577       0.78              .                35
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                              LISTING OF PMP DATA BY POLLUTANT

------------------------------------------------ POLL=TSS ------------------------------------------------

          OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

         2851     111     112677      0.72              .               12
         2852     111     112777      0.72              .                2
         2853     111     112877      0.78              .                3
         2854     111     112977      0.34             83               14
         2855     111     113077      1.15             46                8
         2856     111     120177      0.97             43                8
         2857     111     120277      0.81              .                6
         2859     111     120377      0.88              .               11
         2859     111     120477      0.87              .                9
         2860     111     120577      0.80              .                1
         2861     111     120677      1.03             62               13
         2862     111     120777      1.11             70               11
         2863     111     120877      0.68             70               14
         2864     111     120977      0.72              .               28
         2865     111     121077      0.74              .               15
         2866     111     121177      0.78              .               14
         2867     111     121277      0.90              .               38
         2868     111     121377      0.91             30               16
         2869     111     121477      1.06             35                5
         2870     111     121577      0.68             55                8
         2871     111     121677      0.88              .                6
         2872     111     121777      0.78              .                5
         2873     111     121877      0.90              .                4
         2874     111     121977      0.73             66                3
         2875     111     122077      0.86             73               10
         2876     111     122177      0.92             70               62
         2877     111     122277      0.95              .                2
         2878     111     122377      0.79              .                2
         2879     111     122477      0.82              .               31
         2880     111     122677      0.84              .                9
         2881     111     122777      0.79             50                6
         2882     111     122877      0.71             60                9
         2883     111     122977      0.86             60                5
         2884     111     123077      0.94              .               13
         2885     111     123177      0.88              .                9
         2886     126     100275      0.38            426               33
         2887     126     100575      0.28            671               20
         2888     126     100675      0.33            783               19
         2889     126     100775      0.30            364               25
         2890     126     100875      0.38           1180               38
         2891     126     100975      0.34           2000               24
         2892     126     101275      0.32           5988               14
         2893     126     101375      0.36           7000               46
         2894     126     101475      0.33          14600               23
         2895     126     101575      0.40            422               30
         2896     126     101675      0.49            333               26
         2897     126     101975      0.38            600               23
         2898     126     102075      0.32            544               29
         2899     126     102175      0.33            683               10
         2900     126     102275      0.31           1260               28
         2901     126     102375      0.32           1220               20
         2902     126     102675      0.30            453               30
         2903     126     102775      0.44            443               33
         2904     126     102875      0.53            447               31
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------------------------------------- POLL=TSS ---------------------------------------------

   OBS     PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

   2905     126     102975      0.41            430              30
   2906     126     103075      0.36            813              38
   2907     126     110275      0.29            743              20
   2908     126     110375      0.30            738              32
   2909     126     110475      0.30            393              25
   2910     126     110575      0.37            264              18
   2911     126     110675      0.39            144              19
   2912     126     110975      0.44            550              21
   2913     126     111075      0.58            469              18
   2914     126     111175      0.48            276               3
   2915     126     111275      0.45            560              25
   2916     126     111375      0.49            950              30
   2917     126     111675      0.41            691              16
   2918     126     111775      0.43            379              26
   2919     126     111875      0.44            300              20
   2920     126     111975      0.46            310              17
   2921     126     112075      0.46            475              13
   2922     126     112375      0.36            593              15
   2923     126     112475      0.38            356              21
   2924     126     112575      0.41            293              17
   2925     126     112775      0.40            448              22
   2926     126     113075      0.35            156              11
   2927     126     120175      0.38            308              13
   2928     126     120275      0.33            260              10
   2929     126     120375      0.33            268               7
   2930     126     120475      0.40            376              11
   2931     126     120775      0.38            300              10
   2932     126     120875      0.35            412              14
   2933     126     120975      0.40            538              15
   2934     126     121075      0.30            508              26
   2935     126     121175      0.26            221              11
   2936     126     121475      0.33            265               7
   2937     126     121575      0.38            226              20
   2938     126     121675      0.35            268              10
   2939     126     121775      0.33            260              20
   2940     126     121875      0.36            254              21
   2941     126     122175      0.25            320              18
   2942     126     122275      0.31            287              10
   2943     126     122375      0.34            350              13
   2944     126     122575      0.43            333              12
   2945     126     122875      0.45            360              10
   2946     126     122975      0.45            406              11
   2947     126     123075      0.42            205              10
   2948     126     010176      0.29            240              10
   2949     126     010476      0.45            213              19
   2950     126     010576      0.42            168              22
   2951     126     010676      0.43             64              11
   2952     126     010776      0.32            140              16
   2953     126     010876      0.35            380              10
   2954     126     011176      0.39            360              10
   2955     126     011276      0.40            472              12
   2956     126     011376      0.37            243              10
   2957     126     011476      0.35            260              11
   2958     126     011576      0.32            212               8
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                              LISTING OF PMP DATA BY POLLUTANT

------------------------------------------------- POLL=TSS -------------------------------------------------

        OBS     PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

        2959     126     011876      0.30            392               11
        2960     126     011976      0.34            311               14
        2961     126     012076      0.35            306               11
        2962     126     012176      0.36            300               10
        2963     126     012276      0.33            304               10
        2964     126     012576      0.39            367                6
        2965     126     012676      0.35            429               10
        2966     126     012776      0.35            256               11
        2967     126     012876      0.36            343               34
        2968     126     012976      0.44            435               29
        2969     126     020176      0.45            245               12
        2970     126     020276      0.34            310               38
        2971     126     020376      0.37            392               15
        2972     126     020476      0.38            245               13
        2973     126     020576      0.41            239               10
        2974     126     020876      0.46            246               11
        2975     126     020976      0.42            324               15
        2976     126     021076      0.35            246                3
        2977     126     021176      0.37            444               17
        2978     126     021276      0.34            269                4
        2979     126     021676      0.35            248               20
        2980     126     021776      0.34            104                3
        2981     126     021876      0.36            160               10
        2982     126     021976      0.41            120               11
        2983     126     022276      0.27            154               17
        2984     126     022376      0.31            160               10
        2985     126     022476      0.33            324               11
        2986     126     022576      0.21            168               10
        2987     126     022676      0.30            143               12
        2988     126     022976      0.29            322               10
        2989     126     030176      0.25            123                5
        2990     126     030276      0.31            367               12
        2991     126     030376      0.33            139               10
        2992     126     030476      0.29            161                8
        2993     126     030776      0.23            300               21
        2994     126     030876      0.38            236               14
        2995     126     030976      0.45            216               10
        2996     126     031076      0.37            224               11
        2997     126     031176      0.39            144               11
        2998     126     031476      0.24            256               25
        2999     126     031576      0.33            416               11
        3000     126     031676      0.40            197               24
        3001     126     031776      0.35            126               15
        3002     126     031876      0.29            233               14
        3003     126     032176      0.26            186               21
        3004     126     032276      0.25            148               39
        3005     126     032376      0.26            160               29
        3006     126     032476      0.27           2089               38
        3007     126     032576      0.27           2370               51
        3008     126     032876      0.26            400               30
        3009     126     032976      0.32            393               50
        3010     126     033076      0.39            328               24
        3011     126     033176      0.51            268               39
        3012     126     040176      0.44           1064               23
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                         LISTING OF PMP DATA BY POLLUTANT

---------------------------------------------------- POLL=TSS -----------------------------------------------------

      OBS    PLANT     DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

     3013     126     040476      0.38            179              11
     3014     126     040576      0.30            260              14
     3015     126     040676      0.23            499              16
     3016     126     040776      0.26            514              27
     3017     126     040876      0.25            347              20
     3018     126     041176      0.23            952              53
     3019     126     041276      0.23            231              42
     3020     126     041376      0.26            205              31
     3021     126     041476      0.27            171              47
     3022     126     041876      0.28            148              49
     3023     126     041976      0.33            133              61
     3024     126     042076      0.36            129              28
     3025     126     042176      0.33            340              50
     3026     126     042276      0.33            324              54
     3027     126     042576      0.31            196              58
     3028     126     042676      0.33            435              80
     3029     126     042776      0.28            258              50
     3030     126     042876      0.29            244              75
     3031     126     042976      0.31            144              46
     3032     126     050276      0.33            190              56
     3033     126     050376      0.36            224              38
     3034     126     050476      0.39            214              45
     3035     126     050576      0.30            236              44
     3036     126     050676      0.40            566              38
     3037     126     050976      0.33            710              40
     3038     126     051076      0.37            364              18
     3039     126     051176      0.38            507              40
     3040     126     051276      0.32            390              30
     3041     126     051376      0.43            393              22
     3042     126     051676      0.19            200              24
     3043     126     051776      0.36            313              36
     3044     126     051876      0.35            140              29
     3045     126     051976      0.34            325              25
     3046     126     052076      0.34            500              35
     3047     126     052376      0.25            295              27
     3048     126     052476      0.20           1325              26
     3049     126     052576      0.22           1266              23
     3050     126     052676      0.20           1692              25
     3051     126     052776      0.28            430              37
     3052     126     053176      0.20           1700              12
     3053     126     060176      0.25            400              35
     3054     126     060276      0.41            525              36
     3055     126     060376      0.27           1270              80
     3056     126     060676      0.23           1740              34
     3057     126     060776      0.23           1400              32
     3058     126     060876      0.23           2988              70
     3059     126     060976      0.24           1614              38
     3060     126     061076      0.27            350              31
     3061     126     061376      0.27            230              25
     3062     126     061476      0.41            103              11
     3063     126     061576      0.28            400              40
     3064     126     061676      0.38            213              13
     3065     126     061776      0.45            163              14
     3066     126     062076      0.37            225              29
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                         LISTING OF PMF DATA BY POLLUTANT

-------------------------------------- POLL=TSS ----------------------------------------------

          OBS    PLANT    DATE     FLOW(MGD)    INFLUENT(PPM)    EFFLUENT(PPM)

          3067    126    062176      0.42            480              11
          3068    126    062276      0.50            922              28
          3069    126    062376      0.43           5160              22
          3070    126    062476      0.37           2455              47
          3071    126    062776      0.33            520              20
          3072    126    062876      0.37            480              11
          3073    126    062976      0.39            341              24
          3074    126    063076      0.35            292              19
          3075    126    070176      0.27            307              20
          3076    126    070576      0.28            400              22
          3077    126    070676      0.30            200              30
          3078    126    070776      0.42           1170              22
          3079    126    070876      0.38            188              18
          3080    126    071176      0.27            112              12
          3081    126    071276      0.29            333              50
          3082    126    071376      0.25            343              50
          3083    126    071476      0.30            327              35
          3084    126    071576      0.37            208              57
          3085    126    071876      0.29              .              13
          3086    126    071976      0.28            480              25
          3087    126    072076      0.28            250              13
          3088    126    072176      0.28            230              11
          3089    126    072276      0.37            413              27
          3090    126    072576      0.38              .              11
          3091    126    072676      0.41            292              31
          3092    126    072776      0.46            206              21
          3093    126    072876      0.33            143              15
          3094    126    072976      0.72            117              20
          3095    126    080176      0.41            192              21
          3096    126    080276      0.33            176              10
          3097    126    080376      0.35            208              20
          3098    126    080476      0.33            500              28
          3099    126    080576      0.37            378              18
          3100    126    080876      0.33            295              15
          3101    126    080976      0.31            152              12
          3102    126    081076      0.28            381              11
          3103    126    081176      0.28            240              13
          3104    126    081276      0.36            190              15
          3105    126    081576      0.40            565              25
          3106    126    081676      0.43            358              43
          3107    126    081776      0.35            542              49
          3108    126    081876      0.33            387              20
          3109    126    081976      0.31            230              21
          3110    126    082276      0.21            295              18
          3111    126    082376      0.24            540              31
          3112    126    082476      0.25            263              19
          3113    126    082576      0.23            500              23
          3114    126    082676      0.37            280              14
          3115    126    082976      0.28            160              19
          3116    126    083076      0.32            393              39
          3117    126    083176      0.36            445              28
          3118    126    090176      0.42            390              19
          3119    126    090276      0.54            875              15
          3120    126    090676      0.33            413               9
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                                   LISTING OF PMP DATA BY POLLUTANT

------------------------------------------------- POLL=TSS -----------------------------------------------------------

                    OBS     PLANT     DATE      FLOW(MGD)     INFLUENT(PPM)     EFFLUENT(PPM)

                    3121     126     090776       0.46            226               16
                    3122     126     090876       0.38            313                9
                    3123     126     090976       0.30            299               17
                    3124     126     091276       0.43            400               15
                    3125     126     091376       0.52            430               13
                    3126     126     091476       0.55            347               17
                    3127     126     091576       0.63            313               40
                    3128     126     091676       0.45           1083               37
                    3129     126     091976       0.34            360               20
                    3130     126     092076       0.47            131               11
                    3131     126     092176       0.53            133               14
                    3132     126     092276       0.52            182               17
                    3133     126     092376       0.47            362               10
                    3134     126     092676       0.45            400               10
                    3135     126     092776       0.53            310               21
                    3136     126     092876       0.49            345                7
                    3137     126     092976       0.38            230               11
                    3138     126     093076       0.47            839               48
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APPENDIX III C

PM&F Questionnaire Survey Data for Production and Discharge Flow by PM&F Subcategory

LISTING OF PMF PRODUCTION DATA

SUBCATEGORY=CLEANING

OBS	PLANT ID	PRODUCTION (KKG/YR)	USED (L/YR)	PERCENT RECYLE	DISCHARGED (L/YR)	DISCHARGED (L/KKG)	RATIO (L/KKG)
1	1950	168.0	38155884	85.7	5450841	32478	32445.5
2	1420	2226.0	272000000	90.0	30000000	13500	13477.1
3	1000001N	40.0	91188549	98.0	1583781	39203	39594.5
4	1000001N	85.8	111510000	98.0	1947815	22702	22701.8
5	820	635.0	390000000	99.3	2740000	4291	4315.0
6	500	2412.0	664250000	99.9	692751	287	287.2
7	510	3985.0	70380000	99.9	394147	99	98.9

SUBCATEGORY=FINISHING

OBS	PLANT ID	PRODUCTION (KKG/YR)	USED (L/YR)	PERCENT RECYLE	DISCHARGED (L/YR)	DISCHARGED (L/KKG)	RATIO (L/KKG)
8	2500	2106.0	9850000	70	2950000	1400	1400.76
9	2860	18.1	2271184	100	0	0	0.00
10	480	640.0	445160000	100	0	0	0.00

SUBCATEGORY=CONTACT COOLING & HEATING

OBS	PLANT ID	PRODUCTION (KKG/YR)	USED (L/YR)	PERCENT RECYLE	DISCHARGED (L/YR)	DISCHARGED (L/KKG)	RATIO (L/KKG)
11	2670	798.0	380309693	91.3	9652530	12105.0	12095.9
12	10780	348.0	48100000	91.4	4140000	11900.0	11896.6
13	10730	523.0	72100000	91.4	6210000	11900.0	11873.8
14	260	34700.0	373940000	91.5	31860955	918.0	918.2
15	1000002I	1738.0	270480000	91.6	22712400	13068.0	13068.1
16	250	12076.0	883970000	92.0	69445434	5759.0	5750.7
17	10720	513.0	102000000	93.0	7120000	13900.0	13879.1
18	230	2744.0	385510000	95.0	19194412	6995.0	6995.0
19	833131A	30495.0	3372800000	95.0	168637350	5530.0	5530.0
20	10280	21106.0	753000000	95.3	35400000	1680.0	1677.2
21	120	1857.5	97163647	95.4	4469145	2406.0	2406.0
22	958218B	7504.0	379520000	95.5	17072154	2276.0	2275.1
23	940	5718.0	583900000	95.7	25794018	4511.0	4511.0
24	1945	5977.0	183000000	95.8	7550000	1260.0	1263.2
25	1945	1031.0	275000000	95.8	11400000	11100.0	11057.2
26	580	13918.0	1479000000	96.0	59158352	4251.0	4250.5
27	758818G	2495.0	122650000	96.3	4504626	1813.0	1805.5
28	1060	14866.0	1007300000	96.5	35714795	2402.0	2402.4
29	30	2097.0	5905224	96.7	194811	92.9	92.9
30	10791	3047.0	59000000	98.0	1160000	380.0	380.7
31	581	17533.0	651920000	98.0	9729992	555.0	555.0
32	731637A	3428.0	587380000	98.0	11197213	3266.0	3266.4
33	4015940	3039.0	380430000	98.6	5034393	1657.0	1656.6
34	644737BB	21221.0	2697900000	98.7	35861300	1695.0	1694.6
35	644737BB	41.4	102700000	99.0	1369395	33073.0	33077.2
36	833131F	12701.0	142090000	99.0	1362744	110.0	107.3
37	275857	3402.0	340650000	99.0	3936816	1152.0	1157.2
38	582	14269.0	1307100000	99.1	11675991	818.0	818.3
39	644737WW	4445.0	572350000	99.3	3815693	858.0	858.4

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                                        LISTING OF PMI PRODUCTION DATA

------------------------------------------ SUBCATEGORY=CONTACT COOLING & HEATING ---------------------------------------------

        OBS     PLANT ID      PRODUCTION        USED         PERCENT     DISCHARGED     DISCHARGED      RATIO
                              (KKG/YR)         (L/YR)        RECYLE       (L/YR)         (L/KKG)       (L/KKG)

        40      10460            68000       5360000000        99.6       19800000         292.0        291.176
        41      10371             1665         76900000        99.7         250000         150.0        150.150
        42      581              17533        583780000        99.7        1945998         111.0        110.991
        43      10781             2291         14200000        99.8          23700          10.0         10.345
        44      6537692            953         51515404        99.9            757          55.6          0.794
        45      833131K           2722         95468394        99.9          75708          28.0         27.813
        46      10377             3025         89100000        99.9          28600          10.0          9.455
        47      10376             1653         46600000        99.9          38000          23.0         22.989
        48      362544N           1497        141770000        99.9          49210          33.1         32.872
        49      3200             27032       8759671247        99.9         844114          31.2         31.226
        50      653769Y           2359        104360000        99.9          43154          45.5         18.293
        51      3070              2187        227572507        99.9          18805           8.6          8.599
        52      653769AA          5443        275960000        99.9         123026          52.0         22.603
        53      76001A            1406        388080000        99.9         111000          78.6         78.947
        54      500               2412        307680000        99.9         245521         102.0        101.791
        55      391771E          11902       1143072000        99.9        1180000          99.0         99.143
        56      3210             10478       1364855983        99.9         935000          89.2         89.235
        57      510               3985        741710000        99.9         741643         186.0        186.109
        58      1550               142         62079018        99.9          62338         439.0        439.000
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*U.S. GOVERNMENT PRINTING OFFICE : 1984 O-421-545/3100